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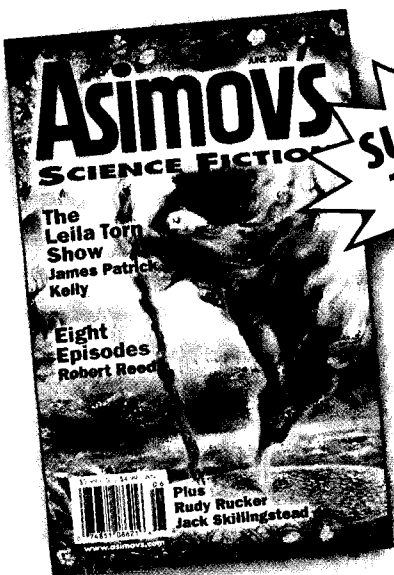
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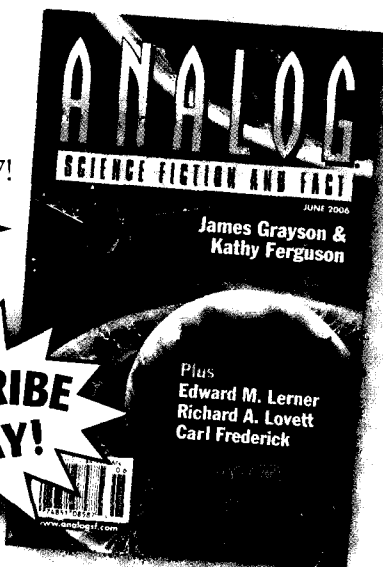
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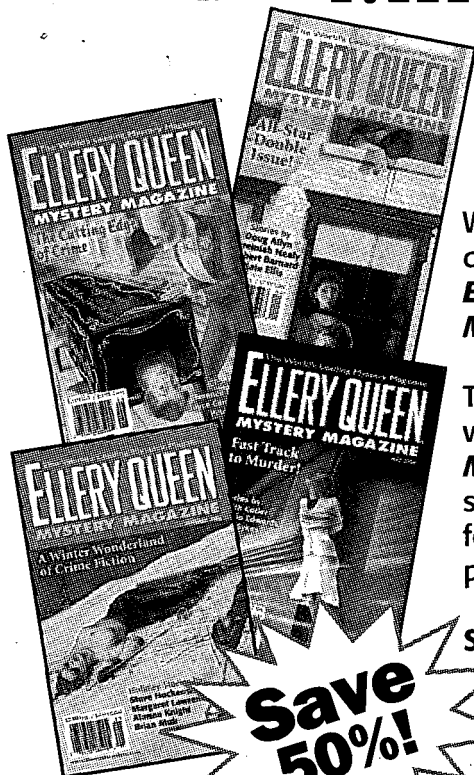
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EXTRACURRICULAR EDUCATION

It's become a popular truism in our culture that many of the most important lessons we learn are not parts of the formal school curriculum. Far be it from me to deny that. In fact, I plan to suggest that it applies even in some ways that people who like to quote it seldom mention—and would just as soon others didn't, either.

Probably any of us can cite examples from our own experience. I, for instance, learned to speed-read (an indispensable tool in my daily work) in school—but probably would have got in trouble had my social studies teacher known I was doing it. (I taught myself so I could read a borrowed science fiction novelette during one of her classes while paying enough attention to get a good grade.) I learned that even highly intelligent, reasonable people can have emotional hot buttons that can trigger sudden and alarming personality changes if you inadvertently hit one of them. And I learned that the more you like and respect a person, the harder it is to forgive them when they unexpectedly and uncharacteristically do something you can't respect.

All of these things are valuable to know, but they're not what my teachers were hired to teach me, or what their employers (the taxpayers) were paying them for. Their main function was to teach me things like English, math, science, Spanish, music, and industrial arts. Those are valuable to know, too, and they should be the top priority of schools. Yes, students will learn some of

those extracurricular life lessons in school, too, but they'll also learn them wherever they are—and they are not the reason for going to school. School is for systematically teaching and learning things that most students are not likely to learn elsewhere, and that are needed to function intelligently in a democratic society.

As I write this, my local polls are open for a vote on a proposed school budget for next year. If approved, this budget will produce a very substantial increase in property taxes that are already some of the highest in the country—and school taxes are by far the largest part of the total. None of this is necessarily a reason to reject the budget increase (which would force the board to adopt a smaller but still quite hefty contingency budget), but it is certainly a reason to question the arguments for it and seriously consider whether they justify the additional burden on taxpayers.

That's where this matter becomes of general enough interest to warrant discussing it here. The school budget of one northeastern town is not, in itself, of any concern to anyone living anywhere else. But the kinds of reasoning being put forth in support or opposition provide a good example of some cultural trends that have a lot to do with where our culture is now and where it's headed in the future.

Which is, of course, a major concern of this magazine and most of its readers.

So: what will be done with this extra money, if a majority of voters agree to

have it taken from their (and their unwilling neighbors') pockets? The most extensive coverage I saw in the local newspaper was a ten-inch article, most of which detailed how the new budget would expand sports options by such means as buying additional equipment and hiring five additional coaches (for two schools) to insure continuation of a "no cut" policy. A considerably smaller part of the article mentioned (almost in passing, it seemed to me) that it would maintain current academic programs and class sizes (on the order of 20 to 25 students).

A mere half-inch was given to the comment of one resident (a retired teacher) that he would rather see the money go to academics.

Well, so would I, if the extra money is approved at all; but I think even that is subject to question. Remember, this is in a time and place where school taxes are already so high, and for several years have been increasing so much faster than the general rate of inflation, that they're literally driving people from homes they've lived in for years or decades because they can no longer afford the taxes. Demanding that they pay still more, I respectfully suggest, requires very compelling reasons.

So what are we offered?

According to the article, the superintendent recognizes that his schools offer unusually extensive athletic opportunities and that that isn't easy. But, it goes

on to say, he believes sports are "crucial to a child's development" because they "keep students active . . . and help them feel as though they are part of a group." (The quotes identify the newspaper's words and not necessarily the superintendent's, since the article apparently paraphrased or summarized.)

If that's what he thinks, that's where his views and mine begin to diverge. Sports were not crucial to my development or to that of many others I knew, so the suggestion that they're "crucial" to "every child" leaves me more than a little cold. And while it may be a fine thing for students to be Active and Feel As Though They Are Part of a Group, I don't think it is the schools' responsibility (or mine as a taxpayer) to make them so. I venture to suggest (and I realize this is heresy in our current culture) that they and their families should take some responsibility for finding worthwhile and satisfying things to do with their time.

I am *not* saying that I think everything athletic should be stricken from the curriculum or from extracurricular activities—or everything musical, artistic, journalistic, dramatic, or whatever. But I do think that the amount of public money spent on any of these things should bear some relation to what the taxpayers can reasonably afford. A "no cut" policy, as I understand it, means that the district provides enough equipment and coaches to run multiple teams in multi-

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ple sports, so that anybody who wants to play one can do so. A nice luxury, if you can afford it, but hardly a necessity so compelling as to forcibly require people who don't want it to pay for it. Radical suggestion: maybe a "no cut" policy is a bad idea. Most people at most schools seem to like having teams that play similar teams from other schools, but what is so wrong with the idea of making those teams something that interested students can aspire to, and be proud of achieving if they do, but not take for granted?

I make this suggestion as one who would not have made the cut for any such team at my high school (which produced some very good professional athletes), and would not have been crushed by my inability to do so. I had my own interests that lay elsewhere, and I wouldn't have wanted to see a "no cut" policy in those, either. My junior high and high school music experiences were some of the most rewarding in my entire time as a student, and I'm grateful to my schools for making them possible. But I would never have expected them to pay for my instrument or accessories, and the experience would have been much diminished if the band and or-

chestra had been thrown open to anyone who wanted to play in them, no matter how ineptly.

I should also add that I have similar reservations even about certain academic extravagances—and, at the same time, that I have been a professional educator (in an academic field), took the job very seriously indeed, and still do. As one of the main places where people are prepared to keep our civilization alive and growing in the future, education is one of the most important professions we have, and deserves all the meaningful support we can reasonably afford to give it.

But is it really necessary for public schools to *give* every student a laptop computer, as some in my local system would have us believe? I'm far from convinced. Even though computer prices have come down dramatically, they're still far more expensive than other supplies such as textbooks—which, at the junior high and high school levels, are typically *loaned* to students. I don't question that computers can be a valuable aid in the teaching or learning of almost any subject, or that they have already become such an integral part of how our culture does almost everything.

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that students need to be able to use them comfortably. I do question whether every student is entitled to a new one as a gift from the public, to use through and beyond his or her time in the school. Why can't those, like books, be loaned for the duration and then reissued to another student? Certainly they can and should last long enough to serve at least two or three students that way.

I have anticipated, and reject, the argument you may make that while computers may physically last several years, they become obsolete almost immediately. True enough, in the bizarre sense that they become unable to run some of the newer software that manufacturers would love to sell us every few months. But there's no reason why students need to have the very latest hardware or software. *Whatever* version they use in school will surely be obsolete, at least in that sense, by the time they get out and go to college or work. So it really doesn't much matter that they learn to use any particular kind of computer or application. What matters is that they learn to use *some* kind, and thereby develop the kinds of general skills and ways of thinking that they'll be able to transfer to other kinds as the field continues to evolve. And they can do that just as well on a five-year-old model as they can on a brand-new one.

I also anticipate your objection that many of them will be frustrated with such equipment because they're used to using newer computers and software at home. Fine, I say; let them use the ones they have at home. In fact, that can further reduce the schools' costs: let the schools provide computers only for those who *don't* already have their own—which is a steadily decreasing number.

As a teacher, I well understand the frustration of using equipment that's antiquated or in poor repair, or of having to teach excessively large classes. As a teacher, of course I would rather teach

15 students than 50, and I would prefer to use brand-new, state-of-the-art equipment. But I don't consider it my inalienable right and expect others to provide me with that opportunity, or to consider their failure to do so an excuse for my failure to teach well. I do recognize that providing me with the best of all possible working conditions is not the only thing they must consider in managing their own finances.

And that the quality of education is not directly determined by the amount of money you throw at it. As Ben Bova observed in a conversation many years ago, "Probably the best classroom ever was a grove of olive trees with Socrates in it."

That grove might not be quite adequate for today's needs, but Socrates could surely accomplish a lot with far less equipment than many people have come to consider necessary. A good teacher or student can even derive educational benefit from learning to cope with less than optimal equipment. (The first comment of special approval I ever got on a college physics paper was on an appendix to a lab report titled "Special Notes on the Collapse of the Apparatus.")

The problem I see shining through the discussion of my local school budget proposal is a far larger one that has come to pervade our culture: too many of us have been so spoiled by the ready availability of luxuries that we have come to regard them as necessities.

Perhaps the most telling quote (or paraphrase) from that superintendent is this: "You never want to limit a child's potential." You may never want to, but sometimes you have to, because you have to live within your means—and that's a lesson worth learning. People have too often been allowed to think that they can get whatever they want just because they want it. Children need to learn that they can't—and so do school boards. ■

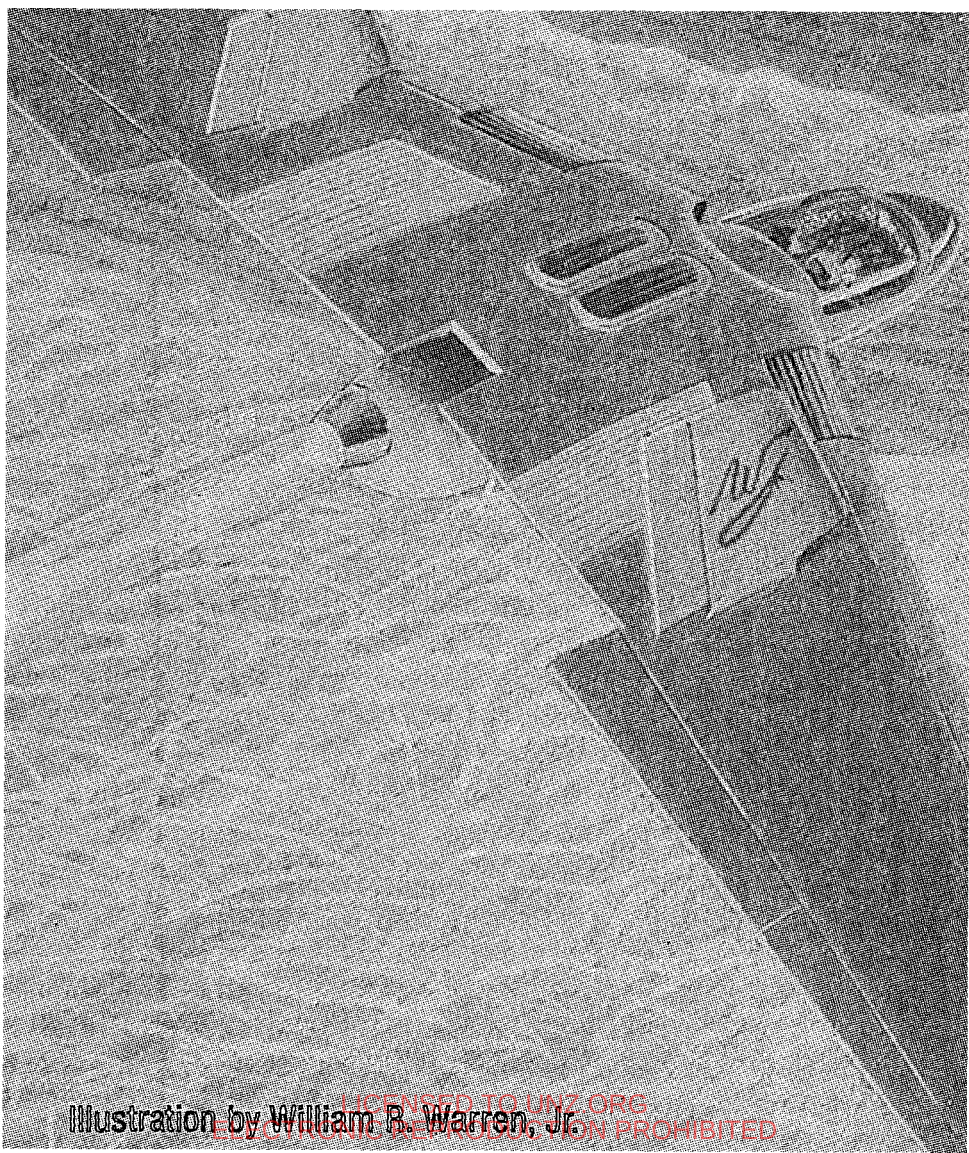
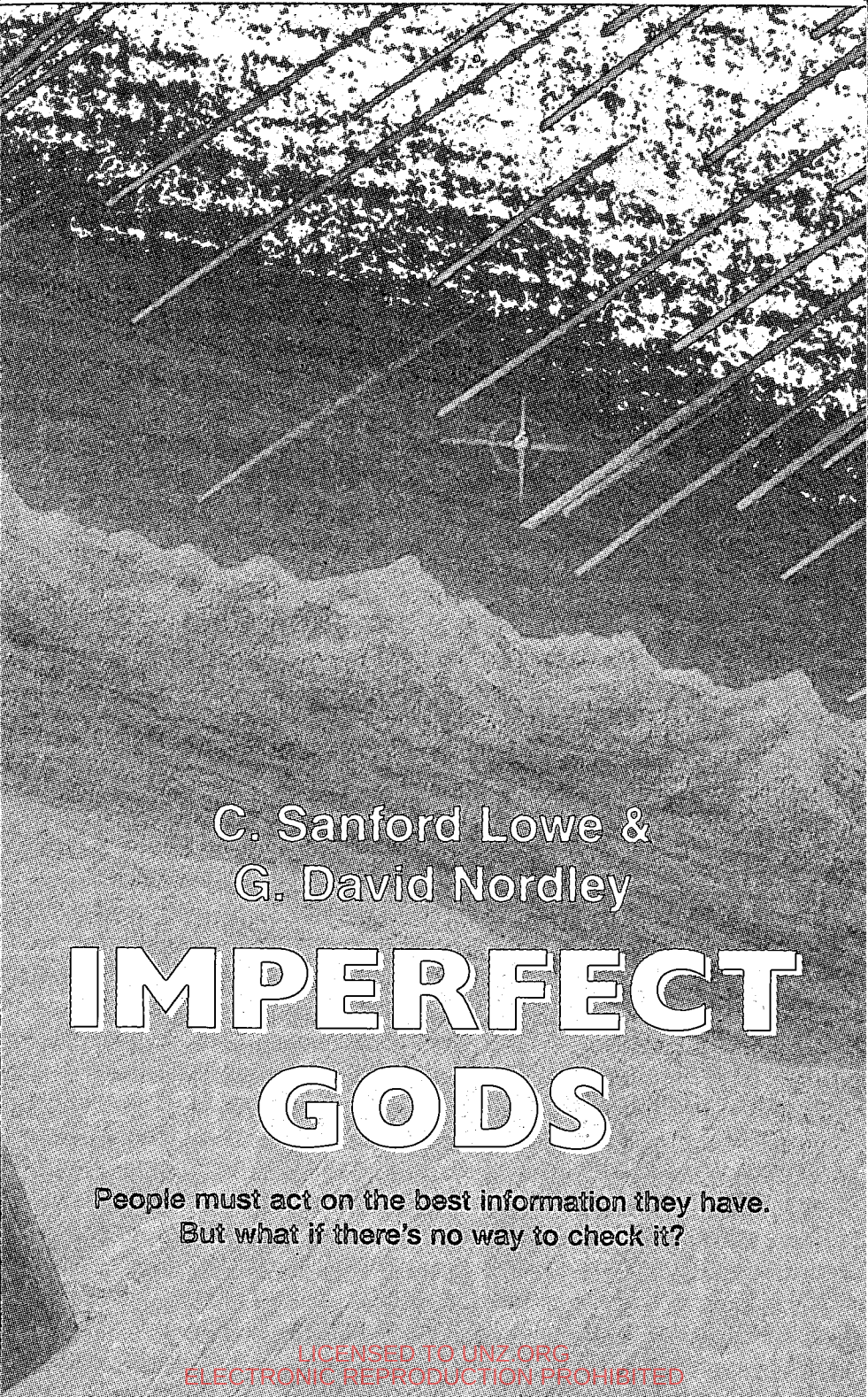


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IMPERFECT GODS

People must act on the best information they have.
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Chapter 1

Spaceport, Planet New Antarctica,
Erebus System, 12 April 2272

She's on that ship, Naomi Abila thought as she watched the incoming interplanetary shuttle rise slowly in the far north like a supernova kicked loose from the firmament, a brilliant point of light that got higher and brighter every second. As it grew brighter and nearer, it began a majestic sweep eastward and inscribed a thin, glowing trace across Canis Major and then Orion. Gently, its path curved back until it was again headed directly for their base on New Antarctica.

Naomi smiled at her son, Sasha. She worried that he might resent having another person becoming, effectively, lead on New Antarctica's part of the project to create a mini black hole. That had been pretty much hers up to now. On the other hand, he idolized Dr. Brunhilda Kremer for solving the Quark star minimum mass problem; all the more since the story had arrived of how she helped derail an attempt to sabotage the project back in Sol's System. And, of course, in a time when age difference no longer mattered, Dr. Kremer was single.

The glow faded from blue-white to dull red to nothing. Flood beams stabbed up past the tiny yellow disk of their local giant planet, Amundsen, into the Milky Way and found their target, a tiny ball so reflective it might have been made of liquid mercury. Rapidly it descended toward them. At first it seemed like a small chromium moon, then, as it dropped lower, Naomi's perspective changed, and she saw the light scatter off a teardrop hull as big as a hill and shiny as a mirror.

A beam of brilliant green glowing plasma lanced up from the landing area and blossomed into a violet flower just beneath the broad part of the hull where its force spent itself against a silent expanse. Distant ice fields around their "dry island" city glowed in response.

The spacecraft slowed and followed the beam down toward the landing zone with the ponderous stateliness of objects of its scale. A hundred meters up, the plasma flickered out and the two-hundred-meter-long teardrop settled down through wind-whipped snow as if held by some giant hand. The sight of a thousand tons of mass effortlessly floating on magnetic fields never failed to inspire awe in Naomi. At times like this her mind went back to ancient legends; we are heirs of Prometheus, she thought.

The port dome flowed around the ship as it slipped down into the colony docks.

Naomi turned to Sasha. "Let's go meet the new boss."

"Us?"

Naomi laughed. "Your Uncle Ted is out at the site and Wotan Kremer's tied up in a meeting about ice sheet slippage."

"Dr. Kremer is his daughter, isn't she? Hard to imagine Grandpa Abila staying away if it were you."

Indeed it would. Dad was always there to greet her when she came back from the construction site, even if only for a week. But Wotan Kremer was notorious for not letting personal matters interfere with business. "Yes, but melting planets has to be done just right. He'll probably see her tomorrow."

"I wonder what they'll call New Antarctica when they're done melting the ice."

Naomi sparkled. "Come on. You'll want to make a good impression."

He chuckled and followed her into the elevator.

She'd reserved a table on the upper level, where they could watch the disembarkation. She liked to watch the new arrivals and imagine who they might be and what their personalities would be like. Sasha shared that general interest, but today was a little more special.

They arrived in the great cylindrical cavern just as massive sections of the shuttle's hull swung aside, exposing its

innards to the business of unloading. The hull was covered with frost and there was a sharp nippy smell to the air just mixed with the icy nitrogen above. They could even see their breath. Sasha tried blowing a ring of mist.

They walked to their table, a semicircle that curved away from the low, transparent guard wall. Four pod-chairs rimmed the table; they took the middle two. She settled into the infrared warmth of the chair and savored the sensation of breathing crisp air. They ordered coffee and watched four ramps slide out from the sides of the cylinder into the ship. A host of robot unloaders rolled down three of them to get to the cargo. Above them was a large sign, "Welcome to New Antarctica. Erebus (Groombridge 34A) Star System." The name they'd given the star was so new that someone had thought to add the old catalog name in parentheses.

A dozen folk emerged on the fourth ramp, hooded against the chill of the still warming air. "Do you know which one she is?" Sasha asked. "Mom?"

"Huh? Oh, sorry. I was just checking with the site on how impactor fabrication was doing. *Icestar* was reporting a concern about defect frequency."

"Mom, those pop media gadflies would make a scandal out of someone's hangnail."

She chuckled. "It's not really important; we'd like the impactor to be a single crystal, but that's not a requirement. That close to light speed, its mechanical properties on impact are almost irrelevant." In two New Antarctica years, their billion-ton iron rod would be the first to head toward the implosion site, a little less than eight light years away. Independently, identical impactors would be launched from Lacaille 9352, Epsilon Eridani, and Sol. Each impactor and each launch had to meet exacting specification and schedule constraints to make the implosion as symmetrical as physics would allow, or the biggest fiasco in human history would result. She was really

not so unhappy to have someone else take responsibility for that.

A hood fell from one of the passengers, revealing a tall blond with wide-set eyes and a long nose. She didn't seem to mind the chill, and she was grinning from ear to ear. She glanced around and Sasha's eyes met hers momentarily.

"Mom?"

"It's her! Dr. Kremer's the tall one." Naomi waved. The woman waved back and headed for the elevator.

"Not bad," Sasha said. "She'll melt someone's iccap."

Naomi smiled. "She looks really glad to be home." At twenty, her son was somewhat of a man-child, brilliant enough in his architectural studies but never quite connecting socially. She worried that she was too close to him, that she hadn't quite lived up to her weaning responsibilities.

Dr. Kremer reappeared on the terrace and headed for their table. She'd shed the hooded cape on the elevator, to reveal a trim figure in a standard gray unsuit. She carried herself with a grace that spoke of diligent exercise.

"Mom, is she an athlete?" Sasha asked. "Thirteen years on a starship and she looks like she could run a marathon!"

Naomi laughed. "About seven years ship time—remember your physics—and people have a lot of time for exercise on interstellar voyages. Sasha, don't jump into the personal stuff right away, okay?"

"Okay."

Kremer held out a hand as she reached the table. "Naomi Abila! How good to see you in person. And this must be Sasha!"

"Welcome to New Antarctica," Sasha said, holding out his hand.

Kremer shook it, smiling broadly, then added, "I just heard everyone voted to change the star name to Erebus when I came out of deep sleep. I love the change—I think."

Naomi patted her on the arm. "You'll get used to it!"

"I got to visit its namesake, the volcano in old Antarctica."

They sat and ordered more coffee, which a robot vendor brought in short order.

Sasha's eyes glowed. "Earth must be amazing."

"It's good to be home," Kremer said to Sasha. "You've just graduated, haven't you? Architecture?"

Sasha nodded. "First year in grad school now, macroarchitecture."

"He wants to design space colonies," Naomi added.

Kremer smiled warmly at her friend's son. "I'm sure he will. What do you think of the Black Hole Project, Sasha?"

"The BHP's just mind-boggling, Dr. Kremer," Sasha said, "trying to get such a precise collision with four-billion-ton impactors eight light years away."

She laughed easily. "You can call me Hilda. And that's about all there's left to do in physics—mind-boggling things. All the easy stuff was done before we were born. We have to be precise, but not perfect. Vertex Station, where the impact point will be, provides the vernier beams and guidance points for the final approach. Then, on December 23, 2284, all four impactors meet the target as planned, and boom! We get a mini black hole."

Sasha shuddered. "Or, boom! The universe blows up!"

Naomi grimaced and tried to think of something diplomatic to say as Kremer's jaw dropped.

"Just kidding," Sasha said quickly. "But we've got some ice-heads here, too, who think it's possible."

"Well!" Kremer shook her head. "I didn't think I'd escape them entirely."

"Anyway, we've got an extra six months," Sasha said.

Naomi stared at him in surprise. "What do you mean by that?" No one had mentioned a delay to her. She looked at Hilda, who shook her head.

"I haven't heard anything like that. Where did you get that, Sasha?"

"Ginny Wu at *Icestar* says a message came in delaying the impact time by six months. Says they're reviewing the calculations and that Wotan asked them to hold it until he gets a chance to talk to you, Dr. Kremer."

Naomi watched Kremer's lips tighten for a brief moment.

"Ginny Wu is Sasha's best friend's cousin," Naomi added. "It's still a small town here."

Kremer took a breath and smiled. "Well. You should have seen it when I was here. Morris Wu—he started *Icestar*—and I went to school together half a century ago. A delay doesn't sound right, though; I should have gotten word directly. Let me double-check . . . nothing."

Naomi shook her head. "Dr. Kremer, uh, Hilda, it could be a rumor or a complete invention on someone's part. Ginny can get a little in front of things at times."

Sasha laughed. "Like when she said the Maluks were New Reformationists and they were just Baptists! It was weeks before all our Martian refugees started talking to them again, just for a rumor."

"Well, I hope that's all there is to this," Hilda said. "You'll let me know before doing anything about it?"

Naomi grinned. "Absolutely! When are you going to meet your father?"

Hilda shook her head. "He's still in a meeting about tidal waves and the planned Maud Plateau ice sheet collapse. Said he'd be here tomorrow. Naomi, I haven't heard anything about a delay, which is surpassingly strange. It's a major change. Brad Adams and Sarah Levine back at Sol's BHP would have sent messages to me. All the traffic I've gotten is completely normal."

"Including the impact date?" Naomi asked.

"That was set seventeen years ago," Hilda said. "The impactor state vector targets are cast in concrete; they're the fixed star about which everything else in the project revolves. The only reason to send a

new one would be some major change.”

Naomi shivered. “Hilda, we do have some Consolidationists here, including three of the ten planetary councilors. Hans Bluth, the security minister, is one of them. Wotan figured that was a good place for a conservative.”

Hilda shook her head. “Some of those people think they’re so right, that anything they do is justified.”

Sasha’s head was turning between them like a spectator watching a tennis match. “What happens if we launch late?” he asked.

Naomi looked at Hilda and both women shook their heads.

“Complete disaster,” Hilda said finally, “of varying flavors, depending on how late and what is done about it, but as far as the project is concerned, complete disaster.”

Chapter 2

New Antarctica, 12 April 2772

Hilda found quarters in Hadley’s Hotel, overlooking the large lake in the center of Dome 2, east of the spaceport. The hotel was a re-creation of the hotel in Hobart where Amundsen had stayed after his return from the South Pole. It was staffed by pleasant android robots with cockney accents. After brunch with Naomi and Sasha, she’d spent the day getting her things in storage and connecting with Shira Hassan, an old schoolgirl friend and BHP team member who promised to call on her.

Shira laughed. “I’ll be the one in the head scarf and long dress.”

“You always had the most beautiful long silk scarves.” Hilda remembered them fondly.

Storage chores done, she took a break and walked around the lakeshore where she and Mom had played. Still there was the fountain where Mom had told her of her decision to head the first expedition to Ross 128. . . .

“I have to do this, Hildy. Kyle Perot

got himself killed in a skiing accident and they need another starship captain. It will be the first ever discovery voyage not mounted from the Solar System; and after sixteen years on my butt, it’s an opportunity I can’t pass up. You can come too, if you want.”

“Will Dad come?” she’d asked.

Mom had been silent for a while. “Your father and I . . . well, sometimes two strong people need to get away from each other for a while.”

“Mom,” she had said, “I love Dad. All my friends are here. School—I’m playing clarinet in the band. Song-Do Chun wants me to go to the Waltz Festival with him.”

“I understand, dear,” she’d said with a smile. “Feathered and flown with projects of your own.”

“Huh?”

“Look up Millay. Don’t worry, dear, we’ll have more time together some day.”

“When are you going?”

“Tomorrow,” Kate Avonford had said. “Tomorrow.”

Hilda remembered the moment as clearly as if it had been yesterday. It had been the end of her childhood. She finished the walk with moist eyes and headed up to her room, to bury herself in the details of expanding the solar power and beam projector array that would push Erebus’ impactor to its rendezvous some twelve years hence. She worked through dinner but made it down to the Lakeside Grill for supper with Sasha. The starship had been on New Antarctica’s thirty-eight-hour, four-meal day since deceleration, but she still felt a bit of a disconnect after all the years on Earth.

She watched a show until the wee hours, and fell asleep easily enough.

A crash of cutlery woke her the next morning. Her room overlooked a large courtyard full of diners busy with their breakfasts; someone must have knocked over a cup. She opened her eyes and decided it was well past time to get up.

ANALOG

Dad would be coming by at noon.

The knock on the door came at 19.6 hours, precisely. Heart in her throat, she opened it.

"Dad!"

Wotan Kremer had not changed physically since Hilda had last seen him, but he gave the appearance of a somewhat more youthful person than she'd remembered. His shoulders were more square, his posture better, his face more ruddy and self-assured.

Of course, the man who had sent her away to Earth at the age of sixteen had been a very sad person trying to put a failed marriage behind him. That had been six decades ago, with a reunion, two more children and another split. Those who are larger than life live by their own rules, Hilda thought. One looks up in wonder and tries to stay out from under their feet.

"Hildy!" He opened his arms and Hilda rushed into them. Sixty years of heartache were suddenly set aside and she was ten years old again, back in the time of birthdays, Christmas trees, and trips out to see the stars. Her eyes filled with tears as she laid her head on his broad shoulders. At length they parted. She rubbed her eyes. Should she mention Mom? What wounds would that open in both of them? Yet to say nothing was like trying to ignore an elephant in the room.

"Katherine sends her greetings from Luyten something or other, wherever she is now"

"I'm . . . I'm glad you're speaking to each other."

"Hmmpf. Well, there are times when I think that the one year between messages is about right. But, *ja*, we communicate. I should have been more realistic; the only way one can keep a butterfly forever is to put a pin through it. Hildy," he paused, "she's very proud of what you've accomplished, as I am. The Ried clan and their allies were formidable adversaries, trying to sabotage your project! But you won't have such

worries now. Here, I am in charge!" He grinned at her.

They had *Mittagessen* of vegetable cake and salad, then talked into the afternoon about family, about Liz going to Lacaille 9352 to manage the final effort there, and Konrad, the brother she'd never met, leading the Colony at Ross 128. They wended their way back to Hilda's room. Finally it was time to talk about the business here.

"Dad, there's a rumor that Earth's directed a delay."

Wotan nodded gravely. "We received it five days ago. I wanted to talk to you about it before I released it."

"I'm glad you did," Hilda said. "Things don't seem right—I would have gotten a message, too. From Zhau Tse Wen, from Brad, or from Sarah—from all of them."

Wotan shrugged. "Our people had some reservations as well. But the orders came right from the BHP transmitter location—our interferometers pinned it down to within a couple of kilometers in the Sol System. The multi-channel signal was continuous, with all the right synchronization codes. There are occasional dropouts, but that happens going through an asteroid belt. I've released it to your access. Go ahead and take a look."

She touched the local net and scanned the numbers. It was basically their standard state vector update, of which there had been several early on, but none in the last ten years. Standard except that the launch epoch was almost six earth months later. The comments field said the change was due to a recalculation of the ten sigma coupling to the probability field for fluctuation inflation.

Hilda's stomach suddenly knotted up. "Dad, there's no such thing as 'coupling to the probability field for fluctuation inflation,' and the BHP certainly hasn't done any tests to look for anything like that."

"Hmmm. Well, that's not really my area, but I understand that many physicists think that the big bang couldn't have happened by itself, that something

external, some first cause, had to trigger the initial period of inflation."

Hilda was about to say she'd never heard of such nonsense when she remembered that she had, and where. "Dad, there was a Dr. Hiram Kokos working with the Consolidationists . . . I think he was making those kinds of noises. He's a planetary astronomer, not a theoretical physicist, and no real physicist takes his stuff seriously. Ask your local physics community."

Wotan shook his head. "Hildy, that would be Brian Lobov, who runs the physics department at our university, and maybe a couple of others who make it a hobby. He's pretty good; I rely on him." He smiled and shrugged. "But there is just not much of a physics community on New Antarctica, even now. We only have about half a million people in the whole system! Why do you think I sent you to Earth?"

Hilda's eyes opened wide.

"Mom left. I thought I was, well, in the way. A reminder."

"Oh, no, Hildy, never that! It was for your physics. You didn't want to do anything else—no boys, no dances, just your equations and your experiments. Hildy, do you remember the argument you had with Alex Leparc about relativity? I thought you two would come to blows! You were, what, eight years old?"

Hilda winced. They *had* come to blows, later, and nobody had ever heard about it because young men don't like losing fights with girls.

"For physics, Hildy, you had to go to Earth. All these years, you never said . . ."

He was completely right, she realized. She could never have done what she did at New Antarctica. But she had not felt that way at the time. Emotions held back for years raced through her. She didn't know what to say.

"I'm sorry, Dad. I just . . . Should I order some drinks?"

Wotan sighed and smiled. "Dry sherry. Our vines have done well."

She placed the order on her bionet.

Wotan kept talking.

"Have you noticed that the glaciers are starting to retreat? Air pressure went over 0.6 bars a couple of months ago, and our mean surface temperature is up to 254, and up to 274 within fifteen degrees of the equator. Things should proceed quite rapidly now."

Hilda's mind shifted gears. "274? Above freezing? Open water? Do you have open water?" New Antarctica had started with a surface temperature of 233 K at the equator, with spots below 173 K at the poles.

Wotan laughed—the deep-throated, powerful, thunderous laugh she remembered from the good times of her childhood. "Not yet, but they've created a betting pool. The bets will peak for a time a few months from now. People keep asking me; I tell them I'm not saying because I don't want to bias the pool. Can you imagine that? It is far too complicated to predict precisely, but they think I know and am not saying!"

Hilda shook her head.

"This is the most Earthlike planet humanity has ever found! Mass, gravity, tectonics, everything. All we had to do was give it a little push, *ja!*"

Their drinks arrived. Wotan swished the dark fluid around his mouth, then abruptly swallowed.

"You must come on an air trip with me and I will show you this world I am building for you."

"For me?"

"Of course for you, if you want it. Why do parents do anything?"

Hilda laughed. No person could own a planet, but as a first-generation founder's daughter, and having made a small mark in human history, she would occupy a unique position here for as long as she wanted. "Okay, but it will have to be tomorrow; I'll be leaving for the site the next day."

Wotan drained what remained of his sherry.

"Done. We'll leave about eight, from West Dome Airport."

After Wotan left, Hilda remembered that they'd left the conversation about the delay unfinished. She touched the net to find Dr. Brian Lobov.

Somewhere, the fates were having fun with her. Dr. Lobov had been a student of none other than Hiram Kokos. Whoever had sent that message had sent it to fertile ground.

The next day, they left early and flew over the ice pack and emerging islands of New Antarctica's Great Equatorial Sea. Their aircraft was a high-wing delta design with a mostly transparent fuselage. Wotan flew with manual controls. He was born before genetically engineered bioradio and had an irritable distaste for prostheses. As long as Hilda could remember, he preferred to do things with his hands.

Wotan pointed out to her where the first open-air settlements would be. "It's a volcanic island chain, with the hot spot migrating southeast, somewhat like the Hawaiian Islands, but a bit larger. You see, the big caldera, Novetna, is now free of ice!"

At his touch the aircraft banked left over the gigantic sharp-edged depression on the top of the mountain. They were cruising at fifteen kilometers above sea level, but the mountain was almost twelve kilometers, and a red-orange glow from a spot in the huge caldera was easily visible.

"It has a lava lake!" Hilda exclaimed.

"Ja, more than one. We will not build too permanently near that one! The next island west is not so active. The government and the university, they will go there. I call it Avonford Island, after your mother."

"You miss her sometimes?"

"I miss the good times. But, Hildy, you must remember she and I are two stubborn people who found we could not make always the compromises two people must make to live together. We both had to be in charge, and that was impossible. Impossible. The fights, those I do not miss."

Together, they watched the icefields flow by below in silence. Hilda brought up the subject again.

"Dad, the university . . ."

"There will be a place for you there, Hildy, if you want it. Dr. Lobov will be glad to have you; he has many new ideas he would like to discuss with you."

"Uh, Dad. I've looked at a couple of his papers. You don't have much in the way of peer review out here, and . . ."

Wotan held up a hand, with a laugh. "Hildy, I cannot get into any physics discussions—not my area—but I am sure that is something you physicists will work out! Perhaps the experiments done with this black hole we are making will clarify things, no?"

Hilda nodded, with the unspoken reservation that some people find it very hard to give up cherished ideas, even with contrary data staring them in the face.

"Dad, I'm convinced there's something wrong with the delay message. The physics justifying it is wrong, but it's wrong in such a way that may not be clear to Dr. Lobov."

"He is a good man, Hildy. You are suggesting that someone has deliberately sent a false message to sabotage the project?"

"I think so. There's been no subsequent confirmation."

"Hmmm. Hildy, would there be?"

"It's such a major change, I'm sure I would have gotten a personal message from Tse Wen, Sarah, or Brad. The physics is such a departure from the standard model that it would be the most important thing happening in physics. But we have no news."

Wotan was silent for a while, then said, "If we send our impactor at the wrong time, it would be bad."

"Very bad."

"I am looking forward to using mini black holes to make a new kind of world, like a ring world, but one that can use the energy conversion properties of a black hole to provide light and propel itself among the stars, or maybe

even to another galaxy."

"Dad, that would take millions of years."

Wotan laughed. "When I was growing up, people got old and died in a few decades; everyone was in a hurry. 'We aren't getting any younger, are we?' they would say about delays. Now we say 'we aren't getting any older, are we?' There is time enough." He reached out and touched her hand. "Hildy, people look up to me here. I have to be responsible and responsive."

He chuckled as if he did not take it very seriously, but Hilda saw the steel in his eyes and thought otherwise.

"I do very much want the black hole to be created," Wotan continued, "and it is a unique honor to be chairman of the Erebus System Commonwealth Council when it is happening. But that means I am not free to do exactly as I please, even where you are concerned, my Hildy."

"Dad, if our impactor is late, and the other impactors aren't diverted, they will make a beam of relativistic matter and radiation that could squirt out our way, spraying over this planetary system. Everyone will have to take shelter. Some of the larger pieces of debris could hit like nuclear warheads. It would be moving so fast that the first of it would arrive only hours after the flash of the explosion. Very little warning would be possible."

Wotan thought for a while. "There is time," he said finally. "The Impactor does not launch for eighteen months yet, even on the old schedule. So no changes need to be made now. We will discuss and evaluate this. Meanwhile, I have something to show you. Ahead, we approach the shadow line."

Their aircraft had overrun morning, racing into night. As the sky darkened, Hilda saw the Vasili range rise before them, painted blood red by the rising star behind them.

"Oh!"

"Ja, but wait a moment now as we go over."

Darkness fell and Hilda soon found the next planet out, Wilkes, rising over the peaks. Almost as bright as Venus from Earth, it was easy to spot over the mountaintops in the crystal clear sky.

"That one is near opposition. A pretty sight. But look down."

The ice below glowed red as far as she could see, as if lit from beneath. A network of brilliant yellow lines could be seen here and there.

"You have heard of the Deccan Traps of India?" Wotan asked.

"The huge lava field?"

He nodded. "Something like that is happening here, beneath the ice. We have removed an immense weight from the local geology. New Antarctica is smaller, denser, and younger than Earth and the demons of its core are less tame." He chuckled at the metaphor. "We have loosed their chains, and this ice is now melting from both below and above. It will be gone here in a few weeks, I think."

"And with it the clear skies," Hilda remarked.

"Ja, for a while, cloudy it will be."

A meteor streaked through the dark sky, and then another. Soon the sky was full of them.

"More nitrogen," Wotan said, "that was once ammonia ice in the Krietzbergelt."

The planet was transforming before her eyes. How many years would she live, Hilda thought, how many star systems might she see, before she saw the likes of this again!

Hilda caught her breath as she approached the nearly completed impactor with staff members Phil Stavros, Shira Hassan, Naomi Abila, and her brother Ted Abila. From ten kilometers out, it looked like an incredibly long, thin beam of light with a spiderweb at one end.

"How did it go with your dad?" Naomi asked Hilda as they approached its dull gray cylindrical surface.

"I was awed by the progress he's made," she answered softly, thinking about progress in all its various guises.

"What about the project schedule?" Phil Stavros asked, swiveling his seat around. He was nominally their pilot, but he handled everything through Als and the net. A youngster of forty, he'd mastered the ability to carry on a verbal conversation while interfacing visually with the net.

"We can keep going for now, but he's not convinced the message is phony. The physics rationale is apparently credible to Dr. Lobov, whom he trusts."

"But Lobov doesn't have . . ." Naomi paused and started again: "He's a nice avuncular showman and students love him, but I know physics better than he does!"

"I know, Naomi. But Lobov has a Ph.D. from Earth. That makes him a god as far as Dad is concerned."

Ted shook his head. "A rather imperfect god, if you ask me. I have an idea."

"Yes?"

"We can add another deflector ring to the design. It will let us push 50 percent harder and give the control system 50 percent more drag to use when it reaches the vertex. We may need some added flexibility—in case there are schedule problems."

Hilda thought long and hard. There was only one thing more important than not getting into a contest of wills with her father, and that was the BHP itself. She closed her eyes. If Wotan were held responsible for the failure of the BHP, his reputation would be ruined forever. Humanity had not yet gotten used to the implications of that word "forever." The ancient words came to her mind: *Cattle die, kinsmen die, a man himself must likewise die, but one thing lasts forever, the doom on each man's life.* Nowadays, one could not even count on death for escape from one's critics. It would be up to her to keep her father from becoming the laughingstock and fool of history.

But even fighting for his own doom, Wotan Kremer could be a formidable opponent. And he was the law, here. Hilda touched Naomi's hand. "We need more of a contingency, and one that is less obviously a challenge to his authority."

"What did you have in mind?"

Hilda shook her head. She tried to remember what she could about leadership. An American general, Patton, had once said something like, *Don't tell people how to do something, tell them what you want done and they will surprise you with their ingenuity.* That seemed to fit the circumstance.

"It's probably best that I don't know," Hilda went on. "Dad can be very clever, and I don't think I could lie if he asked me a direct question. Meanwhile, Ted, I need a favor. You're more attuned to Als and what they can and can't be made to do."

He nodded, looking at her with dark shiny eyes from beneath a mop of short, wavy black hair. He was, she thought, very handsome.

"What do you want me to do?" he asked.

"I've sent you a link to the postponement message. I'd like you to analyze it front and back. See if you can find anything suspicious at all that might indicate a fake—besides the content, of course."

"You mean like using a different version of the spread-spectrum encoding protocol?"

"The what?" Hilda touched the net and was greeted by a two-line definition, half the words of which she didn't know, and a menu of menus, the titles of which would require a trip to a dictionary. She shivered. Just as soon as you think you're hell on wheels in this universe, something comes along to humble you.

"Uh, a spread spectrum protocol is something that determines which bits go where on which frequency," Ted said. "Different protocols work better than others, depending on what part of the solar system the beam is going through and what the solar activity is—

separate Als might differ on what protocol to use, so an abrupt change in protocol could indicate a different choice, or just a change in conditions. But it could be an indicator of a different source."

"Yeah, that kind of thing," Hilda said. "Indicators. Lots of good, solid indicators."

A slight tug on their seat harnesses told them the runabout had reached the end of the impactor. The lines holding the superconducting loops that would pull the impactor up to a gamma of ten looked exceedingly thin, but up close, Hilda could see they were more complex.

"The stays are like lace tubes."

"Yup," said Ted, "almost two meters across. The lacy pattern is due to cross-connections—you could cut any of these stays in a thousand different places, and still tow the impactor. The carbon nanotubes that bear the weight are even thinner. Most of what you see is matrix and shielding. The Groombridge 34 system is fairly young still, 2.734 gigayears by the last measurements, and there's a fair amount of debris around. So we have to design for more contingencies. By the way, have you looked at Bee?"

"Bee?"

"Our other red dwarf. Out that way." Ted waved toward the rear of the impactor.

Hilda followed the motion of his arm and soon spotted a very brilliant orange-ish star.

"Pull up a visual from astroview and zoom in," he told her.

Hilda did so.

"It's only about a tenth the brightness of A," Ted said. "Not much more than a brown dwarf, and the biggest thing in its planetary system is a micro-giant with a Mars-sized core, about three Earth masses of ice on top of that, and two Earth masses of hydrogen, etcetera, on top of that. But it's got a huge asteroid belt—almost a ring system, really—about two tenths of an AU out."

Hilda noticed a dark curved line across the southern hemisphere. "That thick dark band?"

"Yup. The first planet out is a bit off the equatorial plane—probably an escaped moon, an interloper. Anyway, it makes the ring thicker than it would be otherwise."

"Anyone out there now?"

"Less than a hundred researchers and the usual infrastructure," Naomi said. "The main habitat is a toroid—only three hundred meters across." She grinned. "It contains the smallest population of any inhabited star-system that we know of. My other brother's out there and says they're lost in it. It's a good place for independent minds that want to get away from it all."

Hilda thought about the opportunity such seclusion would give her. Time to think. Time to wrestle with the universe without having to worry about projects, schedules, and politics.

"You look wistful," Ted said, laughing.

"Are we already such a pain?"

She shook her head. "No, no. It's just that, well, not everyone is made for what they have to do in life." She sighed.

Their craft rounded the impactor in silence.

"I may have to oppose Dad to make the project happen," Hilda finally said. "I'll need your support and it won't be without risk. Tolerating disobedience isn't one of Dad's virtues; he can be gentle, but only when his control isn't threatened."

"Wotan's our elected leader," Naomi said. "You can't just say no, Hilda. You have to think about the rest of the colony and your responsibility to them!"

"Oh, God, Naomi! I've thought of nothing else. But that's the point, isn't it? That message is bogus. If we follow it, we'll have had a role in sabotaging the most important project humanity has ever attempted. It passes all the authentication tests; but Tse Wen and all would never send out something like that without a viable explanation."

"I can't remember any group, never mind an individual, openly defying the Council president before," Ted said in a

hushed voice.

Shira Hassan spoke up. "We made him give in on allowing traditional clothing."

Hilda nodded. If it had been up to Wotan, there would probably have been a dress code. As it was, the colony colorfully reflected the varied national origins of its people. Her father was stubborn and autocratic, but not impossible when others were clearly in the right.

"He may not feel free to do what he suspects should be done," Hilda said. "You would be saving his name and his reputation as well, though don't expect to be thanked for it."

"Well," Ted said, "it hasn't come to all that yet, and we'll proceed as if this delay order is going to go away. I've got a feast programmed back at the construction shack. Strap in!"

Hilda laughed and had barely gotten her belt around herself when the run-about leapt forward at what must have been a full gee. The construction shack, a golden ring spinning on top of what looked for all the world like a beehive of robots, grew before them. Now that she thought about it, she was hungry.

Most of the crew were there to meet her, and over coffee after lunch, she laid it out for them. A younger woman laughed nervously. "We're just going to buy some time, right, Dr. Kremer? Until something from project HQ clears this up. That's not defiance; I mean we wouldn't really be doing anything irreversible. It's not any worse than, say, pretending you're out of touch when someone rings you. Once it gets cleared up, we say, 'Oh, sorry, there must have been some miscommunication,' and because shutting down would have been a disaster, they wouldn't look any deeper than that."

Hilda shook her head. "That impactor has to be on its proper vector come whatever, or the project may be dead for a long, long time. The Consolidationists are within a razor's edge of a majority back in the Solar System. We may never get another chance."

One of the older researchers raised a hand. Hilda nodded.

"Jake Jabowsky, Dr. Kremer. What if we're all wrong? What if we send our impactor into that asteroid against legitimate orders? What then? Our collective butts will all be *persona non grata* here from now to kingdom come!"

"Cool it, Jabowsky," Phil Stavros said. "That would be nothing compared to what would happen if we're not wrong and *don't* send an impactor!"

Hilda shook her head. "We're not wrong, and I'll be available here for the next ten days to walk anyone interested through the physics. But that's a good point about the consequences. I know we all believe in this project. We wouldn't be here if we didn't believe in it. But those of you who don't think you can survive the consequences should leave now before you are further involved. I hope I can trust you enough to not talk about our intent prematurely." Hilda looked at each of her team members in turn. And then she looked at them again. "Who's with me?"

Jake grabbed his jacket and headed for the exit. He might be a useful witness when this is all over, she thought ruefully. No one else left.

Ted raised his coffee cup. "To launching on time, come honor or chaos."

"To launch!" a dozen voices cried, and they all clinked their coffee cups together.

"Looks like we're in with you, Hilda," Ted declared.

Hilda allowed a few nanoseconds for relief to drain tension from her shoulders. Then she smiled at her team. "Let's get back to work then, and be thinking about how we'll do this."

Weeks full of quiet tension became months of quiet tension. Finally, just to ease the stress, she agreed to go swimming with Sasha in the dome's center lake where she had swum as a child. Too late, she realized that swimsuits were forty years out of style here. She looked studiously straight ahead as she walked

naked into the icy water and quickly submerged her body up to her neck. *It couldn't have been this cold when I was a kid*, she thought, between ragged gasps. Finally, she got used to the temperature and began to relax.

"Something's bothering you," Sasha said, swimming over next to Hilda. "Something more than cradle robbing, I hope?"

His young impetuosity made her laugh. It was much needed. "Cradle robbing? If you were sixty-five and I were twenty, would that be cradle robbing?"

"I guess so. It's okay as long as it's fun, I think. I mean, we'll live forever, and if I were a million and eighteen and you were a million and sixty-five it wouldn't make much difference."

Hilda laughed. "It's hard to imagine what we'll think when we're a million years old."

"Are you cold? Do you want to warm up on the sand?" Sasha asked. He began to lead the way toward the shore.

She shook her head and glided back away from the shore. Sasha joined her. He took one of her hands and rubbed it as if warming it. The floor of the lake had fallen away and they were treading water.

He turned his body and brushed himself against her. "I can warm you up a bit more. Doing it with people watching slides easy, here." He took her other hand and rubbed it. "Uh, you don't mind do you?" he asked.

She didn't mind it, she realized, any more than she needed it. Her mind was far elsewhere, fragmented in time and space. She was in her room, three quarters of a century ago, simulating solar systems while other kids went swimming. She was watching the data come in from the black hole they were making, a dozen years from now. She was skimming over endless fields of solar arrays last week, drinking in the power to make it. She was listening, then and now, to her father telling her to pay attention to other people's ideas and not act as if she knew everything. She was

with Brad in Lillehammer, a long time ago and now with this urgent young man beside her whose attentions she did not, in some existential sense, mind at all; they just were. Her whole life was of one cloth.

His hand caressed her cool skin and she didn't mind.

But she had better pretend she *did* mind, or things could slide down the slippery slope of major embarrassment. She pushed him back and laughed. "Give me another year or two to get used to the idea. Meanwhile, the impactor launch will be excitement enough."

Sasha's eyes went wide. "The old man give the okay?"

Hilda shook her head. "I'm going to talk to Lobov and see if I can convince him to help us persuade Dad."

"Terry's in Lobov's class—thinks his ice is clear."

"Which means?" The metaphor didn't ring a bell with Hilda; as familiar as the colony on New Antarctica was, it was different, too. Her mother had never been topless in public, that she knew of, let alone totally naked. But there was not one swimsuit in sight. She'd been away.

"He can see all the way to the bottom of things—real deep."

"And Terry is?" Always check the quality of the data . . .

"One of Jennreh Poi's cocks," Sasha said, as if that explained something.

"Students?" Hilda asked.

"Huh? Oh sure. Terry's a grinder. He's talking about going back to Earth to study under Dr. Kokos. The First Causes guy."

Despite the warm male body next to her, Hilda shivered. "Sasha, I don't think it's a good idea to mix religion and physics, but it's even worse to mix them and not be honest about what you are doing. This Jennreh . . . is she a lover of yours?"

"No such luck. She's an artist, Kama Sutra and all."

Hilda looked at him. "I didn't really mean to pry. Everything is so much

more open than before. It's just not a big part of my life."

"Sex?" He looked incredulous.

"That. Not a big part of my life."

Hilda felt his hand leave her skin. "Damn, why had she said that" was written all over his face. "Look," she said, "Jennreh and Terry, do they talk about Lobov? What he says in class?"

Sasha pulled back to the moment. "Some. Uh, they are into something they call 'intuitional science.'"

Hilda looked at him with a raised eyebrow.

"It's the idea that the broad sweep of things must first make sense at some higher intuitive level so that if you're really in tune you can just, uh, *understand* the fundamentals of what's going on and the details, equations, and math aren't really as important. Dr. Lobov kind of smiles at that and makes them work quantitative problems anyway. But Terry says Dr. Lobov has a lot of questions about the assumptions behind things, like he's not sure the standard model is right."

"Anything about the BHP?"

"Terry said Lobov said the BHP isn't necessary for science unless it shows the theory is wrong. But if it can show the theory was wrong, it shouldn't be done because it would be unsafe. Uh, that's kind of complex." Sasha sighed and frowned. "If you want to talk to Terry, I guess I could set that up. But watch out for his come-on."

Hilda looked into Sasha's brown, pleading puppy eyes and placed a quick kiss on his cheek. She sighed. "There's not much time, so I'm going to have to go with what I've got. Thanks for giving me an idea of, uh, how clear Lobov's ice is."

Sasha smiled. "That's okay." He hesitated, but only for a moment. "Uh, do you want me? Even a little bit? Or am I acting like a complete idiot?"

Hilda laughed. "What would your mother think?"

Sasha rolled his eyes. "I think she'd be relieved. She keeps trying to fix me up

and it keeps not working."

"Oh? Why is that?" Hilda instantly berated herself for teasing. She needed Naomi's goodwill, and her guess was the mother doted on the son.

"I guess I don't have the timing right. Like with you now. Or like when a girl wants to do stuff, maybe, and I keep talking. That kind of stuff."

Hilda put an arm around him and kissed him again on the cheek. *Why not*, she thought. *It would be an act of grace*, she smiled to herself and reached her fingers out as if to touch Sasha one more time. She stopped herself and let the water cool her down. *First things first*, she told herself.

"Can you meet me tonight? After my meeting with Lobov?"

"You . . . Really?"

"Really! In my room in Hadley's Hotel. About 3130?"

"Yeah. Sure. I mean if you really . . ."

Hilda put a finger on his lips, then, with as much dignity as she could muster, stood up and walked to her towel on the beach.

Dr. Lobov was disarmingly friendly and ebullient as he ushered her into his simply furnished, open office area overlooking Dome 4's central park. He was tall, with wide shoulders and deep blue eyes. Hilda noted he wore a jet-black jumpsuit, unrelieved except for a polished silver cross within a circle, decorating his belt buckle.

It might, Hilda thought, be an Earth symbol, or a Christian symbol, or just a design.

"Wotan tells me you might consider joining our faculty!"

Hilda smiled. Young people moved in and out of the area freely, except for a serious young man with a dark goatee sitting in a lounge chair in a corner, staring off into space. Having been there, Hilda knew he was likely working his virtual rear end off in some simulation that only he could see.

"I haven't taught in years, but as long

as I'm here . . ." She shrugged.

"We'll have thirty-two incoming major students next year. We really should have two introductory sessions. You know how we do it here?"

Hilda shook her head.

"The whole class meets once a week and just talks about concepts and ideas." Lobov waved an arm in the air. "The programs take the students through at their own pace, and alert us if someone is having trouble. Then we have appointments to help them through."

Hilda nodded. "I did my undergraduate work on a starship that way. The captain helped me at first, but I'm afraid I got ahead of him a bit. I took my degree exam after deceleration, did my senior orals, and graduated the first week I was on the Farm."

"The Farm?"

"Stanford."

Lobov smiled and shook his head. "Well, it certainly seems to work okay. But here, we mentor."

"I'm sure it helps, and I do look forward to talking with students again. I haven't had any experience with undergraduates, though . . ."

"You'll love it! Fresh minds ready to be shown the way!"

Hilda laughed, then brought up what she came for. "Dr. Lobov, I need your help. Are you aware of the political problems the Black Hole Project has had on Earth?"

Lobov frowned immediately and nodded gravely. "Not everyone here feels we are ready for it, either."

She gave him a wry smile. "I'm very sure that the delay message was a covert product of the opposition and does not reflect the views of the leadership of the BHP, nor the position of the government. I need to convince Father of that. I know you think highly of Dr. Kokos, and the reason given for the delay seems to follow from his work."

He nodded. "Yes, so it seems. But I think there is a 'but' to this, no?" He flashed a quick smile.

Hilda sighed. "If we look at Kokos's paper with Sun and Kreshkov in 2102, the threshold they calculate for what they call a 'seeded inflationary fluctuation' is three orders of magnitude higher than what the BHP can generate. So this isn't really consistent with Kokos, either. I've put the work up under my name and Kokos's. I'd like you to take a look at it."

He frowned more deeply and waved at his wall screen, which promptly displayed the equations. He studied them, nodding, then shook his head. "When we are so close to the cutting edge of what we know, maybe three orders of magnitude is not so much." He rubbed his chin slowly. "I will have to look at this more carefully. It has, you will appreciate, been some time . . ."

Any undergraduate at Stanford, Hilda thought, would have had no trouble with what she had given him. Trouble was, she needed this man's help. She deftly disguised her shock with a smile.

"Of course, Dr. Lobov."

He nodded. "There may be something to it, but what your people back in the Solar System . . ." He raised a hand. "Peace. I acknowledge that you think the change did not come from your people. But the argument itself *is* in the scope of the broad, intuitional thrust of Kokos's work, the modeling details . . ."

Hilda could contain herself no longer. "Dr. Lobov, that's a fourth power in the denominator! To reduce the triggering threshold by three orders of magnitude, the Johanssen quintessence multiplier field would have to be *twelve* orders of magnitude higher!" Not that there was any evidence for any such "quintessence multiplier field" in the first place. She bit her tongue on that because it was one of Dr. Kokos's pet hypotheses. One did not win a physicist's support by attacking the pet hypotheses of his mentor.

"Do we know that it is not?"

"I think we do. A QMF that high would produce billions of little universes at every gamma ray burst! That clearly doesn't happen!"

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Lobov shook his head. "I'm not sure . . . I . . . I'm just not sure." He smiled weakly. "Perhaps, you . . . we . . . are missing something obvious. QMF seeding is such an elegant, clear solution to the first-cause problem that it *feels* right."

"But I'm not asking you to give up QMF, just to recognize that, quantitatively, it can't apply to the BHP."

Lobov sighed. "I'll have to study it more. You do raise some interesting points."

"Will you say that much to Father?"

He shrugged and grinned. "That would not be so much backtracking for me. I have never claimed certainty about the universe-seeding concern, only that it was defensible in light of the first-cause principles—qualitatively, of course. Well, now!" He brightened as if a storm cloud had passed. "Can I at least talk you into a seminar series next year? On the famous Kremer's limit?"

By that time, she realized, the impactor would be launched and the last pusher pellets en route to it. Suddenly, she appreciated that her role in the Black Hole Project would be over. She would be just one of many investigators at the end of a fire hose of data—most of which would be of more interest to engineers and relativists than someone whose specialty was ultradense matter.

She was home. She had a new life ahead of her. It was time to start thinking of that.

"Of course," she said. "Let's talk about the schedule after you've got your new class settled in."

Lobov laughed. "Speaking of which, the day has moved on a bit, hasn't it?"

Hilda smiled and nodded as she rose. It was approaching 3000. The student with the beard was still sitting in the chair as she left. As she turned to wave from the door, her eye happened to fall on an old-fashioned 2D image hanging in a frame on Lobov's wall. She turned quickly and walked away so Lobov would not see the shock on her face. It had to be fifty years' old, at least. Lobov

had been on New Antarctica for some thirty-eight years. A lot of time for things to change by some standards, less by others.

The picture was of Lobov with two men and a woman in a residence, probably on Earth—Earth, because the other people in the picture were Torsten Ried and his older brother Lars, leader of the anti-BHP Consolidationist Alliance.

Hilda wasted no time leaving the building. Once outside, she called Wotan, then rushed toward his place in Dome 3. Short dim-red lights illuminated the darkened evening pathways. Brilliant stars of the Southern Cross and Eta Carina overhead provided enough light to make out the various features of the landscape. Someone briefly opened a door across the lake from her and the brilliance of that little bit of artificial light hurt her eyes. She blinked hard and saw the reflection of Scorpius on the still lake, remembering that, as a child, she had imagined it a sea monster about to emerge and devour her. The air was crisp; New Antarcitians had always enjoyed a vigorous diurnal temperature change. Alas, this was no time for her to tarry, with two appointments yet for the long local evening.

As she neared the passageway connecting Dome 2 with Dome 3, she heard footsteps behind her and turned. A dark, unrecognizable shadow was right behind her.

"Dr. Kremer," the person said. It was a man, by his voice—a cold, flat, unwavering voice.

"Yes? Who are you?"

"I am a warning. The impactor launch will be delayed. The message will be obeyed."

Suddenly, the night seemed chillier.

"The message is a fraud," she said. Quickly she touched the net and asked it to record what she heard and saw.

"We are not concerned with who the message comes from, only that it is obeyed, and that you do nothing to sub-

vert your father's direction that it be obeyed."

"He hasn't given that direction."

The figure began walking away. It was real enough. She could hear the crunch of sand under his feet. No, that could be faked, if needed. Should she chase it? Run in the other direction? Or keep her composure as if nothing had happened? She decided on the last, and began walking briskly to Wotan's home. On the way, she queried the net and found that the voice was untraceable. What was she dealing with?

Wotan had a glass of wine waiting for her and was not in the mood to talk about the BHP. Rather, he talked about the growing colony and how, in a few decades, people would walk around on New Antarctica in shirtsleeves, and the only ice would be near the poles or on the tops of mountains.

"Then," he mused, "maybe I will move to Bee and start all over again. I will have to build a whole planet there, do you know? It will not be a big one—maybe the size of Luna. If they let me, that is."

"But you're . . ."

"I'm not in charge there. It is a separate star, no? There are only a few people living there, but they decide their own things. Maybe they will surprise me! They are building their own starport—did you know?"

Hilda shook her head.

Wotan laughed. "It will be a long time before a starship stops there that does not come here first, but it is a symbol for them. Everyone gets to dream, no?"

"Father, we need to talk about the Black Hole Project schedule."

Wotan frowned.

"If we do not launch our impactor on schedule . . ."

"I am all for launching the impactor on schedule. The question is whose schedule? Yours, or the one the project sent you?"

"They didn't send that."

"Hildy, who else would have?"

"The Consolidationists. Lars Ried and his crew. Lobov knows them—he has a picture of the Ried brothers hanging up in his office."

Wotan shook his head again. "Now we have conspiracy theories!"

"Backed by the fact that the message cites physics that are wrong."

Wotan kept shaking his head. "I have only your opinion for that, against that of every other physicist in the system."

She couldn't believe what she was hearing. "Have you polled them? How many have you talked to?"

Wotan's face clouded as if he were going to yell at her the way he had when she'd been late for family outings or forgotten her housekeeping chores. Surprisingly, he said nothing, and his features softened.

"I forget sometimes that you are not who you were, Hildy. You have been around the block some and have a right to your thoughts. Please remember, however, I have been around much more than you, and I must make the decision. Absent any proof other than what only physicists can quarrel about, I have to take the message as valid. If I were to do otherwise . . ." He shook his head. "There are people here who think I have been leader too long. What I do must be understandable, or I lose the support."

Hilda saw her dream begin to crumble before her eyes, all because of this stubborn old man who could not see, who would not think.

No, that wasn't fair. She was the only one who knew, the only one in the whole damn planetary system who *knew*. For everyone else, it was politics, dueling experts, and belief. Very well, what political argument could she make?

"Father, you know that verse from the Havalmaal? *Cattle die, kinsmen die, so oneself must likewise die. . .*"

" . . . but what dies not is what is said, the doom that lies on each man's

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head," Wotan finished.

"If you are the cause of the BHP failing, what will history have to say about you, down through eternity?"

"Not good, I grant, if you continue to oppose me, Hildy. If we are both wrong together, then neither of us will hurt too badly. If we both insist on being right in opposite ways, then only one of us will be right, and the other will suffer."

"There is time yet."

"Ja, there is time. Do you know there is enough open water now that plankton may survive? Maybe next month we will seed the equatorial sea!"

So, Hilda thought, wryly. When it gets uncomfortable, Wotan changes the subject. They still had not had a good talk about her mother.

Hilda reached the door of her room feeling drained, betrayed, hopeless, and on the verge of tears. As the nineteenth-century style door swung open, she saw Sasha was waiting for her in a T-shirt and running shorts. "Sasha! How..."

"It's a small town, Dr. uh, Hilda. The desk clerk is Holly Wu's aunt. She let me in. Uh, if this is a bad time..."

They had a date. A million years ago, she'd made a date with him for 3130 and it was almost 3200.

"Looks like you had a bad meeting," Sasha said, worry written on his face.

Hilda smiled wryly. "It did not go well, but we're still alive for the time being. Why? Do I look like I just got out of a three-gee simulator?"

"You're kind of drooping a bit. Could you use a hug?"

He stepped forward and opened his arms. Without really thinking, she did the same and met him halfway.

The door swung shut behind her on its own—only the appearances of Hadley's Hotel were early twentieth century.

Chapter 3

New Antarctica, 23 October 2273

Over the following year, a few brave

pioneers had moved to the equatorial islands as spectacular icebergs fell into the newly open seas of New Antarctica. Hardy plankton had begun to grow there, and Wotan was predicting fish within a decade.

Meanwhile, impactor launch preparations were coming to a head, but Hilda still had nothing other than physics and faith in her colleagues that they would prove the delay message was, indeed, fake. The camaraderie she enjoyed with her father had become strained; the elephant in the room was now a dinosaur. If either of them mentioned it, they argued.

Meanwhile, Sasha continued to ask Hilda for dates. Her status as Wotan Kremer's daughter and chief BHP scientist in residence allowed barriers to be erected to most such distractions, but since Sasha was Naomi's son, he had access. And she gave in, more often than not.

Thus, when Wotan asked to see her on a serious matter, she thought it was Sasha, and not the project schedule, he wished to lecture on. But no.

"It is time to make a decision, Hildy. In my position, I cannot, absolutely cannot go against the direction from Earth and the guidance of the best scientific advice available."

"Father, *I am* the best scientific advice available."

Wotan shook his head. "No, Hildy, you are my headstrong little girl, too stubborn, too committed, too involved. I know you." He tried to smile kindly. "Even if maybe you are right, why are you so impatient? The project will be tried again, in fifty years, in five hundred. What does it matter, now that we live so long? I am sorry, dear, but your efforts to get people to try to make me change my mind have not had much effect. I am saying no."

How did he know? Not that she'd made any great secret of her visit to Lobov, or the university chancellor or the local news outlet people; but she

hadn't done that publicly and Als weren't supposed to spy on personal communications. Then she thought about the quiet student in Lobov's office and the mysterious warning she'd gotten on the way. The conclusion that led to chilled her.

"Father, are you having me followed?"

He smiled. "The security service, such as it is, has someone keep an eye on you, yes. It is precautionary only, for your own protection. This they do for me, and the other council members and their families, too, so it is nothing to be worried about."

Oh, chaos! Security was in the hands of a Consolidationist! Hilda couldn't find words. Everything fit together now in the wrong way. She gritted her teeth. Tse Wen, Brad, and Sarah were counting on her to make this impactor launch happen. A knot grew in her stomach. Come on, girl, she told herself, you're supposed to be a genius. There has to be a way out. Oh, where was the way out of this? She thought about timelines, construction rates, terminal guidance, ways to cheat, crazy stuff that she didn't have time to analyze. Time. Then it hit her.

"Father. Look, we can have it both ways. I can have a second impactor built, and we can launch the first one at the old time and the second one at the new time, and divert or hold the second one when confirmation of the original schedule comes in."

He shook his head. "Which it will not. Then we'll have this whole conversation over again!"

"I can live with that." But could she? It cut through her like a knife.

Wotan laughed. "You are like the condemned prisoner who put off his execution by promising to teach the king's horse to talk. I will not die. You will not die. And I doubt very much this horse will learn to talk." He scrunched his face in thought. "This idea of yours will give you, what, thirty days, before we would need to divert the first impactor? No, I

think that would be too late. We will make that twenty days—before we step up to peak power. You have twenty days to prove beyond any doubt that the day after tomorrow is the correct impactor launch date, or you will shut down the impactor propulsion."

"But the other impactors..."

"Brunhilda Beatrice Kremer, I am enough of an engineer to know that in the very unlikely event you are right, they will have made provision to divert the other impactors as soon as they see ours isn't there. Twenty days. This is what we plan, this is what we will do."

"New Antarctica days," Hilda said. That would make it just over a terrestrial month. She smiled inwardly at her small victory. Sarah had sent personal messages all along, and her last message had arrived in the final stages of impactor launch preparation. The next one should arrive just before the final power ramp-up.

Wotan shook his head with a laugh. "Ja, New Antarctica days."

Hilda found Sasha waiting for her with drinks when she returned to Hadley's. She suspected that, over the months, he'd even started to anticipate her moods. That usually pleased her, but tonight she once again felt drained, betrayed, hopeless, and yes, even a bit desperate.

He handed her a glass of dark red liquid with a twinkle in his eye. "They just started distributing this new vintage from our grape vines. I got us a bottle!"

"Thanks," she said. "Sasha, I..."

His lips covered hers, stopping her from saying she wasn't in the mood. With a sigh, she kissed him back perfunctorily. Then she drained her glass.

He filled it again. "Something wrong? Want to talk?"

She took another drink and shook her head. "Later." The stress seemed to become a little less unbearable. Sasha's young hands were all over her, she noted almost abstractly. The initial buzz of

the wine was warming her, and she made no effort to dissuade him.

The petting felt good, maybe just what she needed. Getting in the mood, she pulled on his waistband and guided him to her bed. But, as their clothes found their way to the floor, she glanced at the camera pickups in the room and tensed up. Of course, the system had eyes everywhere. There were very good, unbreachable safeguards built into the artificial intelligences that ran the system and normally, nobody thought of them. But her father, she knew all too well, often considered himself above the limits imposed on ordinary people. She imagined the safeguards breached and Dad, his agents, and all their friends watching.

"Hilda?" Sasha asked. "What's wrong?"

She looked at him. Still maybe three or four years from full maturity, he was beautiful as well as handsome. Maybe because of the wine, or pheromones, or just reaching some limit on how much she was willing to fear, she felt her attitude change. To hell with them. She gave in to desire.

"Ouch!"

"Oh, sorry!" Hilda pulled her fingernails out of Sasha's skin, stroked him soothingly—she hoped—and laid her head on his shoulder. "Too much happening today; I'm somewhat mixed up inside."

"Well, I'm not."

She laughed and went along for the ride.

Afterward, she let her head relax into the softness of his neck. Sanity faded back in and with it all the worries, all the things that had to be done. How much could she ask of Sasha?

"I'm using you," she said, staring him in the eye. "And I know that's what I'm doing."

Sasha grinned, his wide glistening eyes bored into hers, and he squeezed her hands. "If this is being used, use me! Whenever you want me, Hilda. Go ahead. It's okay."

"I hope you don't hold it against me later."

He shook his head and chuckled softly. "Actually I was hoping someday we could share space or something. Maybe a trial contract? Maybe..."

She put a finger on his lips and shook her head. "Maybe, someday, when I'm not three times your age, and you know a little better who you are."

He sighed and looked pleadingly at her. "Whenever you want me. Whenever."

She bit her lip. There was using and then there was really using. But she was in a bind.

"Do you like Bach?" She reached over the bed for her bag and pulled out a music wand.

"Oh. Classical music?"

She nodded and a fugue filled the room. Then she nuzzled her head into the pillow beneath his. They'd have to have sensors in the pillow, or on their faces, to pick up what she'd say now. Not impossible, but maybe more than they'd bothered to do. She hoped.

"Can I really trust you?" she whispered in his ear. "Completely?"

"Sure," he said. "What is it?"

"Do you believe me when I say that the impactor has to be launched on time, that the delay message was bogus, and that the entire project depends on that impactor getting pushed to the impact point at the right time with the right velocity vector?"

"Uh, sure, Dr. Kremer."

She laughed softly. So in his mind, the Dr. Kremer that ran the BHP was not the same person as the naked woman beside him. Like an ancient Greek goddess, her various aspects must be given separate names.

"We may have to defy local authority to do it. There will probably be consequences."

"For you, anything!"

"You know how pushing the impactor works—by shooting a torrent of tiny pellets at the reflector fields? Like

pushing a paper cup with a water hose?"

"Yeah, that's pretty basic."

"Right. Well, the launch time and velocities of the pellets are arranged so that they arrive in a steady beam to provide constant thrust. The last pellets to arrive at the impactor have the longest distance to go, and they need a head start. Power requirements almost triple at that point. Anyway, Wotan is giving me until then to find evidence that the delay message is wrong."

"That's . . . uh, only twenty days from now!"

"Yes. The problem is that the only jury Dad will believe is loaded against me: Dr. Lobov and his students. I'm reduced to hoping for some message from Sol to come in that explicitly mentions the schedule, which no message is likely to do because the schedule has been fixed for years! I need you to help me keep it going anyway."

"Let me get this straight. When . . ."

"Quietly. I want you to help me do that."

"I could end up frozen," he whispered.

She hugged his body closer to hers. "They wouldn't execute you . . ."

Sasha laughed. "No, no, that's 'ennay' talk for being put on ice—uh, they take you off the net and confine you to quarters. That's the worst, unless, of course, you want to be terminated. That's only been done once—a girl had a baby by someone that dumped her, so she dumped the baby. Outside. When her ice got clear, she didn't want to live with that memory. So instead of being frozen, she asked to be allowed to die. She took some pills. Anyway, getting frozen is still pretty bad." He looked at her directly. "But I said anything. What is it you'd want me to do?"

Hilda kissed him softly and whispered, "Ask your mother if she can find a way to prevent the AI controlling the beam driver arrays from following Wotan's orders for a couple of days."

"Sure, but why me?"

Hilda put a finger to his lips. "I have a feeling everything I say to Naomi is very closely monitored." She told him about the incident on the way to her conference with Wotan. "So this may be my last chance to communicate honestly, and I'm taking a chance on that. You need to tell her that everything I say to her from now on, I will say with the expectation that our Consolidationist friends, Wotan's security people, or both are listening in."

All languidness had fled. Sasha was wide-eyed. He looked around the room, as if searching for bugs. "Do you think that they, ah, are watching us?" he whispered.

Hilda laughed. "I don't know." To the room, she said, "Are you?" and watched Sasha's expression. "Just kidding," she added, wishing she meant it.

Sasha kissed her cheek. "What do you think Mom can do?" he whispered.

Hilda thought hard. On one hand, the less Sasha knew, the less trouble he would be in. On the other, it was likely her last best chance to communicate freely to Naomi. "Okay. An AI is supposed to obey authority as long as it doesn't get anyone hurt. When authorities conflict, it obeys the higher one. I'd argue that since the BHP is a project of all humanity, and I am its representative, I outrank Wotan as far as the BHP is concerned. That's the case she needs to make. I've already filed all my physics objections."

"Aren't the AIs smart enough to choose because of that?"

"Not where human orders are concerned. What I'm counting on is that first, the fact that I'm right means people might be harmed if it doesn't go as planned. That appeals to the first law of AI ethics. Second, I have a case to be in charge, and that should work for the second law."

"Sounds like a lock to me."

Hilda shook her head. "If I can think of it, Father will think of it and so will

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other people who will come up with a way to counter it. Naomi or Ted might come up with something better. Sasha, I'm a physicist. I want to see if all the little strings sing the way we tell them to. This cloak and dagger stuff leaves me with a pain in my gut. I wish Sarah were here."

"Sarah?"

"Dr. Sarah Levine. She's a lot more, well, enthusiastic than I am. She'd be having fun with this." And, Sasha, too. Hilda thought. Oh, would Sarah have fun with this young man.

Said young man put his lips on hers. She melted into him, then found herself sobbing uncontrollably.

Chapter 4

Hadley's Hotel, New Antarctica,
14 Nov 2273

Hilda watched the impactor launch from Hadley's, alone. It was less dramatic than the launch of a starship. The program brought up the pellet wind slowly, to avoid exciting any vibrational modes in the long thin structure. It took an hour for the violet reflection plume to grow bright enough for the cameras to see.

Okay, we're off. Hilda sent to the operations crew at the control center. It was all deliberately low key, given Wotan's reluctance and the political problems that made for anyone associated with the project.

Naomi sent back a feed full of cheers, totally innocent. Except that Sasha gave Hilda a big wink. Hilda smiled, poured herself a brandy, and went to sleep.

A month later, Ted Abila looked at the highly magnified and enhanced view of the departing impactor relayed from a big interferometer telescope in the orbit of the giant planet Amundsen. The pellet streams of a hundred-thousand-plus beam projectors converged in a very narrow, ghostly cone on the head of the impactor, visible only by the red lights

strung out along its length. At the tip of the cone an intense glowing ring sparkled with the detonations of millions of particles each second and gave rise to a diaphanous rose of varicolored light, an ever-shifting aurora of recombining ions that trailed back along the length of the impactor. Delicate as it looked, the ethereal flower represented a wind of billions of newtons pushing on the immaterial magnetic sails of their baby. The long iron rod had absorbed an unbelievable amount of energy from the solar arrays circling Erebus, almost as much energy by now as its entire rest mass. Possibly all for naught.

The beauty of it made Ted sigh. Already two light days distant, its velocity was up to eight tenths of light speed with three days to go. There still had been no confirmation of the launch dates, new or old, however, and Wotan was still adamant about turning the beam drivers off, as Hilda was about keeping them on. He knew that she was right; the delay message cited fringe physics that very few who knew anything took seriously. He had hoped he wouldn't be forced to act on his knowledge.

The time had come, however, to choose between his career, his position here at New Antarctica, the trust of its leadership, and the completion of the most ambitious project begun by humanity since the terraforming of Venus started. He had made that choice and would honor it.

He touched the net for the AI controlling the beam array. *Thorin, confirm shutdown cancellation authority.*

Shutdown cancellation may be ordered by the designated representative of the Erebus council chairman, currently Wotan Kremer. It may also be ordered by this AI if needed to save human life. Finally, Dr. Hilda Kremer, as representative of the Human Commonwealth for the Black Hole Project, may cancel shutdown if needed for the continuity of the project, if physically

present at the control center and not under duress.

Thank you, Ted answered.

Ted stared at the beam reflection aurora for another minute, then sent a prearranged message to Sasha. They had debated whether Hilda should have come and camped out at the project control center, but had decided against that as being too risky. It might signal their intent to defy authority. The cover story—that she was coming out to tell the staff about the shutdown in person—should be plausible enough.

But Ted had thought long and hard about the words “should” and “plausible enough.” He had decided he was not going to risk everything without a fallback position. So he also sent a message to his brother at Bee, innocuous enough, but containing the word “disestablishment.”

The next four days, he thought wryly, would be very interesting.

Two days later, by simple chance, Hilda happened to be looking down from her balcony into the courtyard of Hadley’s when Sasha, just back from the operations center, walked through on his way to the elevator. The staff was replacing the breakfast tables with casual rounds, creating something of an obstacle for him to weave his way through.

They rarely met casually anymore—not a falling-out, but simply reflecting mutually incompatible schedules and the fact that Sasha had other more appropriate “projects of his own.” Nonetheless, Hilda felt a kind of parental or sisterly fondness, and she was very happy to see him. Her eyes followed him across the courtyard.

She suspected why he had come; the truce between her and Wotan was over and the war she did not want was about to begin. The look on his face told it all. He was miserable about something.

One of the staff turned to speak to Sasha. The face looked familiar. In a moment she had it. He was the lean, goateed “student” in the corner of Dr.

Lobov’s office when she had first come. As Sasha left the courtyard, the man waited a bit, then left his table. With an almost military bearing, he followed Sasha—as did two other workers. Hilda stepped back from the balcony, her mind awl-hirl piecing it together.

Security. Minders. They could be there only for one purpose—to keep her from going off planet. It meant they knew about the plan.

She smiled to herself. They didn’t know she knew they knew, at least not for a couple more minutes. She looked down; there was another balcony below her. Almost without thinking, she snatched a sheet from the bed, tied it on her rail, and was over and on the way down as the room announced Sasha’s presence at the door.

The lady in the room below had the double doors open. She looked up from a puzzle with wide-eyed shock as Hilda plopped down on her balcony.

“Dr. Kremer! Is there something wrong?”

“Yes, but I can’t take time to explain. I need to use your room portal to get out!” Hilda said as she brushed by.

“Of course, but . . .”

Hilda was out the door and didn’t hear the rest as she fled to the right. Security would be watching the outside, she imagined. So if she simply ran out of the building, it would likely be into the arms of her father’s security forces.

“Sorry!”

Lost in thought, she’d bumped a group of Moslem women headed into the women’s room. Hilda looked at the long dresses and beautiful headscarves and wished she had time to ask about Shira.

“My fault. Not paying attention to where I was going . . . Shira?”

“Hilda! I hoped you might be here. My mother and aunt wanted to . . .”

The two friends looked at each other. Shira pulled Hilda close to her ear. “What’s wrong?”

Hilda squeezed her arm. “It’s too com-

plicated to explain, but I have to get out of the building quickly, without someone seeing me."

Hilda stared into her old friend's dark eyes, silently pleading. Shira would be risking a lot to help her.

Shira didn't hesitate. "You could wear my scarf and coat, then leave with our group."

Hilda was dumbfounded, but there was no time to argue. She nodded. "That might work."

"Come!" Shira urged.

The little tone in Hilda's head signaled an urgent message. It was from Sasha.

Hilda, are you home? It's urgent!

He must know about the people following him. They had gotten to him, of course. There's no way a twenty-year-old could resist that kind of pressure from authority.

I'm with a friend, Sasha. Is everything okay?

I'd better talk to you in person. Can't explain.

It's going to have to wait a couple of hours. Make yourself at home. I'll be back about 1900.

Then she exercised her option to drop off the net.

Five minutes later, covered from head to toe and in the middle of a group of similarly costumed women, Hilda walked out of the lobby. Ten minutes later, keeping only the scarf on her head, she was on the tube headed for the spaceport.

The *Fram* was in dock under the mammoth dome, due out in three hours, but getting on it would be a problem. If she tried to sign on the normal way, security would have her in a moment. Touching the net would immediately reveal her location, as would using any comm station. She made do with keeping her head down to avoid what comm cameras she could locate.

Finally, she spotted a tall man in a uniform with a *Fram* crew patch on the margin of the landing field, watching some robots maneuver a large piece of

equipment onto a dolly. Hilda removed her scarf altogether. She decided to take the chance and walked up to him.

"Hello. I need your help."

"Huh? You are?" He brushed a shock of sandy hair from his forehead and scratched his head. He had a thick moustache that wiggled a bit when he spoke.

"Dr. Hilda Kremer. I have to get out to the project control center. Hans Bluth is trying to stop me, so the less I have to tell you about it, the less you'll be involved."

"Security! What makes you think I won't call them right now?"

"I've gotten lucky twice today. Once more is all I need."

He laughed and offered his hand. "Vanya Karinoff. Are you sure you want to do this?"

Hilda nodded.

Karinoff sighed. "Well, I'm about done here, and I think this is something I should bump up to the Captain. Of course, he's on the ship." He gestured to the huge dark egg standing to the side of the field.

Hilda smiled. "Let's go."

They had to walk almost a hundred meters across the cold polished rock, utterly alone in the crisp still air. This would never work, Hilda thought. She felt totally exposed. They would be watching for her. At any moment she expected a squad of security officers to surround her. It was the longest hundred meters she'd ever walked in her life. She watched her breath condense into a thin fog. Through it, hundreds of people wandered, ate, talked in the upper galleries around the landing field. Most watched her casually, some not so casually.

Then, finally, they reached the ramp, climbed it, and were in the ship.

"This way." Her escort led her down the toroidal corridor that circled the base of the ship.

Hilda breathed a sigh of relief as they moved out of view of the entrance. With a great deal of good fortune, she would be in orbit by the time Sasha and his se-

curity escort ran out of patience.

"Outboard number ten," Karinoff said. "Captain Martee's in and will see you. I've got to run." He tipped his cap.

"Take care, and thank you, thank you!" Hilda gushed.

He gave her a quizzical smile and a brief wave as he disappeared quickly around the bend.

Was there a warning in that smile? Hilda knew nothing at all about Captain Martee. She briefly considered fleeing around the bend the other way and ducking into a closet or something to stow away. Probably wouldn't work, she decided. There'd be cameras and other sensors in every place big enough for a person. Instead, she focused her mind on the task at hand. She had one more person to sell on the merits of her cause. She touched the entrance pad of the door, and it hissed upwards.

What she saw hit her like a brick in the stomach. The room was nicely appointed, with pictures of historical spacecraft on its curved walls and comfortable-looking aerogel furniture with shiny metal tables and a desk placed throne-like in its center. There, behind what was presumably Captain Martee's desk, sat her father, Wotan Kremer. He was not smiling.

"You are going to answer some questions, Brunhilda," he said.

Focus vanished; she felt a renewed chill in her veins. Time momentarily stopped. Then a light jet of odorless gas caught her in the face.

Four days later, Hilda and Naomi were brought to the council chamber by security escorts. Wotan was there, with Naomi's father Akaabe, Dr. Lobov, Security Minister Hans Bluth and several council members. The wall at the end of the chamber displayed an image of the still-accelerating impactor. The place smelled of a fresh cleaning.

That smell reminded her of the hospital room where she had spent three of the last four days—in a drug-induced

stupor. Presumably, she had told them everything she knew, but she couldn't remember anything more than soft lights, quiet voices, and the clean, anti-septic smell of the place.

Yesterday, she'd woken in her bed in her hotel room, turned into a prison cell. The doors would not open and she had no net access. The last time Wotan had done that to her, she'd been eight years old. He was all smiles now. The beam projectors had been shut off four days ago, the off pulse arrived at the distant object two days ago, and the view of what happened would reach New Antarctica in a few minutes. He wanted to rub it in, she suspected.

A very determined self-destruction, Hilda thought. Her father's reputation would never recover from this—he would pay for his role in sabotaging the project through as much of eternity as he cared to live. So let him have his fun now. She walked stiffly to a seat and glared at him, wondering if he would see any of the pity in her anger.

"We are a community of laws and of authority deriving from the collective," Wotan declared after everyone had been seated. "Five of us have tried to put themselves above those laws."

Naomi's father jumped in before Wotan could say anything else. "Your daughter represented the collective of humanity. One can make the case that it is *you* that has defied it!"

Wotan sighed. "Akaabe, I have the floor. Does disrespect run through your entire family? Wait your turn. If legitimate authority is not heeded, we have chaos. Is there some small chance that the message directing us to delay the impactor launch was not genuine? Perhaps. But the decision concerning what to do about it lies with the collective and not with individuals. We are here today to show that legitimate authority succeeds because it represents the will of many, and many have cooperated to uphold it. Colonel Maluk." Wotan gestured to a man that Hilda recognized as

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the bearded "student" in Lobov's office, who now wore some kind of gray jumpsuit uniform with discrete pips on its shoulders along with the New Antarctica patch below his right shoulder.

"Thank you, Mr. President. Formally, this is a disciplinary hearing to state charges and recommendations concerning the behavior of Brunhilda Kremer and Naomi Abila in willfully disobeying lawful directives of the representative of the council. A jury of peers will be assembled to judge the gravity of the offense, the prospects of a repeat, and the appropriate action, unless the respondents waive that procedure in favor of a determination by the council president. Which, I might add, would save a great deal of trouble in an open-and-shut case. The three who have fled in exile to Bee have, for all intents and purposes, chosen their own fate."

Hilda barely heard a word, the voice itself taking all of her attention. It was, of course, that of the dark stranger who had accosted her on the way to visit her father after the conversation with Dr. Lobov. Colonel Maluk, of course, was a Consolidationist and probably had been promoted as such by Hans Bluth.

Wotan nodded. "Thank you, Colonel. We will hear from respondents and representatives in a moment. Now is the time to see the futility of their efforts. In precisely ten seconds, the beam will cease to push the impactor."

All eyes went to the screen. At the appointed second, the glowing ring at the head of the impactor vanished and a wave of darkness shot backward, extinguishing the aurora of its progress.

"Thy will be done," intoned Hans Bluth.

Wotan frowned at him. "We have a secular proceeding here. And it was our collective will."

The security minister smiled. "As you will have it, Mr. President."

"Damn!" Colonel Maluk shouted and pointed at the wall, "That isn't funny. Give us the real feed again."

Hilda turned to the wall screen again and gasped. The reflection aurora was back again, somewhat wider, she noted, and the cone looked like it was coming in at an angle to the impactor, as if from a different direction.

Wotan closed his eyes momentarily, then said in low, measured tones. "It is not, apparently, a jest. The beam that has resumed pushing the impactor is coming from Bee."

He glared down from the council table, first at Naomi, then at Hilda, looking for all the world like a cornered animal prepared to deal death to its tormenter at the first opportunity.

"Ted did it!" Naomi squealed. "He got Bee to keep pushing the impactor."

Wotan brought his ceremonial gavel down on the desk so hard that it broke, but nobody so much as tittered in the silence that followed.

"We are still in session here," he said, "the stakes of which have been raised considerably by this *unforeseen* treachery." He turned to Maluk.

"The respondents didn't know about this," growled the Colonel. "Our methods are reliable."

"Wotan," Hans Bluth said. "This is what *you* get for being so sanguine about those elitists setting up their own government."

"And what would you have done?" Wotan snapped back. "Organized some kind of an expedition against them? Start interstellar warfare?" He turned to Hilda. "Brunhilda, I don't care if you didn't know about this . . . this scheme. You are responsible for it. I hold you completely responsible."

Then he sighed and shook his head. "For chaos' sake, what can we do now? Allow me for a moment the fantasy of thinking I have been correct in this, and assume that we have sent an impactor six months ahead of schedule. What are our options?"

Hilda spoke as evenly as she could. "We send word ahead. Our transmissions will arrive months before the im-

pactor. It wouldn't receive terminal guidance anyway and would miss the impact site by several astronomical units. Then we send the other one on the revised schedule. This is what we should have planned to do anyway; the effort to not send the impactor on the original schedule was never anything more than a Consolidationist plot to sabotage the project!"

"The remorsefulness of the respondents is noted," the security minister intoned, getting nervous chuckles throughout the room for his irony.

"Enough, Hans," Wotan said. "Brunhilda, I suppose you would maintain that it isn't necessary, but would you humor me and send word forward as to what has happened?"

"I'll need to have my net access back."

"Wotan . . ." the Colonel growled.

"Peace, Maluk," the security minister said. "She's done all the harm she can. Your access is restored, Dr. Kremer."

It was like having her sight restored. Hilda quickly had the incoming backlog sorted for messages from the Solar System; there were a dozen text messages and a video of a celebration at the BHP institute. Tse Wen, Sarah, and Brad were there. Hilda checked the time stamp and smiled inwardly.

"This needs to go on screen, everyone," Hilda announced seriously.

Wotan shrugged and nodded.

The party scene lit up the room in contrast to the previous spacecape. Dr. Sarah Levine, in a painted-on black thing with an impossibly plunging neckline, came to the fore.

"Hi, Hilda, and everyone, from 11.63 years ago. We've timed this party scene to arrive as you celebrate the completion of your impactor launch . . ."

There was an audible gasp from Wotan and several others. Dr. Lobov got up and made his way out of the room.

" . . . when ours will be on its way, too," Sarah's image concluded.

The screen went dark. "You've made your point, Brunhilda," Wotan said.

"Can we go now?" Hilda asked.

"This is still a disciplinary hearing," Colonel Maluk said. "The merits of the issue are beside the point. I will remind you that a number of people here and in the Solar System do not regard a success of the BHP as a good thing. At any rate, you broke our laws."

Wotan nodded. "You are out of order, Colonel Maluk, but correct."

"Dad!" Hilda shouted. "We've saved your reputation. We saved you from the consequences of the biggest—"

"Quiet!" Wotan shouted. Then he added, more gently, "Some things, however true, are better left unsaid. I appear to be acquiring some hard-earned wisdom in that respect. Unlawfulness is still intolerable, whatever the result. Will you accept my judgment? And will you, Naomi? Or do we have to go to trial?"

Such a trial would savage her father, Hilda realized. He would lose his council presidency. Someone else would preside over the completion of the terraforming project. She couldn't do that to him, or to those who supported her. Wotan's blood was still strong in her, after all.

"Mr. President," she said formally, "Naomi and the others followed my direction. I had both project and local authority under you. What was done was my responsibility. Leave them alone and I will submit without trial."

Wotan looked at his ministers who, under the circumstances, appeared to want a trial no more than he did. At any rate, Hilda saw all the heads nod. Colonel Maluk sat, impassive, lips tight.

They were, Hilda knew, rapidly exchanging views over the net of what should be done with her. She had a pretty good idea of what the decision would be as well. It seemed the only one possible. All her dreams of coming home again, of reconciliation, of seeing New Antarctica bloom, were likely gone.

Finally, Wotan tapped the gavel head on the desk, waited for quiet, and said one word, hard and cold. "Exile." He

looked to his right and left. No one objected. Then he got up and left.

Hans Bluth reached over and took the remains of the gavel. "I, I will entertain a motion to adjourn."

One of the other members mumbled something.

"Hearing no objection, these proceedings are adjourned." He shrugged and set, rather than pounded, the amputated gavel head down. Everyone started talking as the councilors unceremoniously filed out of the room.

As the chamber emptied, Naomi and her father came up to Hilda, who still had her security escort. The guard backed away a couple of meters to give her space.

Naomi hugged her. "This will blow over. He'll get over it."

Hilda shook her head as tears ran down her face. "I'll go to the Vertex, I think. Try to make myself useful there. Maybe I can come back someday."

"I'll miss you. We'll all be thinking of you twelve years from now, you can count on that."

Twelve years, Hilda thought bitterly. Twelve years was the time it would take the impactor to get to Vertex plus the time the news of what happened would take to get back. One fifth of her lifetime so far.

She smiled inwardly at that thought and tried to imagine how she would view the passage of twelve years when she was a million years old, or a billion. Then she thought of some unfinished business with someone for whom a dozen years was still half a lifetime. The sentence would take effect quickly, she realized, and she might not get another chance.

"Sasha?"

He came over to her, looking miserable. "I'm sorry. They ordered me to cooperate, Dr. Kremer, and..."

Hilda placed her finger on his lips, then wrapped her arms around him and gave him a long, sensual, unabashed hug. "No hard feelings," she said. "Take

care of yourself. Have fun. We'll see each other again, someday. Okay?"

He smiled. There were the beginnings of tears in his eyes.

She brushed her lips against them briefly, then wordlessly turned and left the room. Naomi walked back to Hadley's with Hilda, past the school, the lake, and the other places of their childhood. She had been home such a short time.

She was off planet again by 3400 that day.

From her room a week later, Naomi pulled up a view from the Amundsen astrogration facility. Under moderate magnification and viewed from almost directly behind, the back-splash of a departing starship looked like a ring of fire, or rather a circular aurora, with the ship itself a particularly brilliant spark in its middle. Hilda is there, she thought, probably cold-sleeping through the high acceleration departure. At four gravities, she would be near enough to Vertex to see the impact within hours of the event.

It was, she noted with some irony, Fathers' Day on the New Antarctica calendar, and she reminded herself to send a message... no, she would walk over. It had been at least a week. He would lecture her about getting involved in politics and then smile because he was secretly proud that his daughter had done something wonderful. They would share a hug that was all the more precious for the cold edge in Wotan Kremer's voice when he had sent *his* daughter away again. Naomi asked whatever gods there might be that a tiny bright new star lay at the end of Hilda's journey—that Wotan had not sent her from one broken dream to another. ■

(EDITOR'S NOTE: "Imperfect Gods" is another tale of the Black Hole Project, the beginnings of which were chronicled in "Kremer's Limit" [July/August 2006].)

Floatworlds

Stephen L. Gillett, Ph.D.

They're an old science fictional standby,
but how likely—or practical—are they?

CS. Lewis's *Perelandra* contains what noted SF author and critic Brian W. Aldiss has called "... arguably the loveliest portrait of an imaginary planet ever written." At one point the protagonist finds himself plunked down into the world-girdling oceans of Venus. He is able to pull himself onto a floating forest, a living island supporting a lush paradise of both plants and animals. Lewis follows with lyrical descriptions of a verdant landscape whose very topography continually changes as it passes over the ever-shifting waves beneath.

Ah, the lost wonders of Wet Venus!

But the fact that it's hard to imagine a less oceanic world than Venus has proved to be doesn't mean that "floating forests" don't exist *somewhere*. They're a familiar SF setting on ocean worlds, even right here in *Analog*: in James H. Schmitz's *The Tuvela* (Sept-Oct '68)¹, and Daniel Hatch's "In Forests Afloat Upon the Sea" (Jan '95), just to name two off the top of my head. In both cases, "floatwood forests" (to use Schmitz's

name) drift around with ocean currents and support entire ecosystems of other living things.

Of course, all-ocean worlds are a common topic in serious speculation, too. H₂O makes up only 0.028% of the Earth's mass, and of that, 81% is in the oceans. It wouldn't take a lot of tweaking to (say) double Earth's water complement, especially if the bulk of the oceans comes from water brought in by the last few icy impactors during accretion. It's even been suggested, by David Brin, that maybe our Earth is deficient in H₂O relative to similar planets. And in turn, such otherwise Earthlike planets have been thought to be bad bets for technical intelligence, because it's hard to see what would replace fire and metal in developing technology. However, if "floating forests" can evolve, all-ocean worlds may not be such bad bets for technical intelligence after all.

But why have they never evolved (so far as we can tell) on Earth? After all, even our very own "Earth" becomes largely sea at times. Plate tectonics goes

¹ Republished, for some unfathomable marketing reason, as *The Demon Breed*.

in fits and starts, and during times of very active seafloor spreading, the mid-ocean ridges swell and displace water onto the continents. During much of geologic time the low-lying parts of the continents have been covered by shallow seas, so-called "epeiric" seas. Indeed, the classical geologic record, which is based on continental rocks, is largely the chronicle of "the seas go in and the seas go out." Only in the latter half of the twentieth century was it realized that these "transgressions" and "regressions" of the sea are merely incidental to the motions of whole continents.

In fact, the Earth's land area is unusually large right now. The oceans haven't stood this low since the Triassic or so, ca. 250 million years ago. So although maybe it's obvious why "floating forests" don't exist on the Earth *now*, at least above the scale of sargasso seaweed, we still return to the question of why they've never existed.

Well, maybe there's too much land even at the height of a transgression. Statistically, a floatwood forest simply couldn't drift very far before running aground. Schmitz implied his floating forests lasted for centuries, if not millennia, and it seems very little land indeed could protrude above the sea surface for that to happen.

A more subtle issue, even with the land out of the way, is that a floatwood forest would represent an enormous resource for sea life. It will have to protect itself to avoid turning into dinner for grazers of all sorts. Unlike a land-based forest, it's also attackable from below. Sure, on Earth burrowers of various sorts (gophers, grubs, and so on) can attack the roots, but that's a lot more difficult than grazing! A floatwood forest, by contrast, would be *most* vulnerable to grazing from below.

But large creatures (whales, squid, plesiosaurs, etc.) have managed to survive in Earth's oceans, and plants would

have a big advantage over animals in that they don't have to continually seek prey. They, of course, feed themselves automatically, using photosynthesis. Moreover, not too many things eat logs, even on Earth, so cellulose-lignin structures (i.e., wood) might resist grazers well. After all, driftwood on Earth doesn't get eaten. It can even host various passengers, too—barnacles, birds, maybe a small animal or two.

This leads to a more fundamental issue, though. Where would the nutrients come from? Sure, the bulk of a plant just comes from the air and water. Cellulose is polymerized glucose, and glucose in turn is a simple sugar made from CO_2 and H_2O by photosynthesis. The nitrogen in proteins could also come from the air, assuming some equivalent of nitrogen-fixing bacteria (and assuming atmospheric nitrogen!)

But terrestrial life—and presumably LAWKI² elsewhere—requires more than the four biggies of CHON (carbon-hydrogen-oxygen-nitrogen). Metals (iron, manganese, copper, zinc, etc.) for enzymes; calcium salts for skeletons, neurotransmitters, and such; phosphorus, if the life uses anything like terrestrial adenosine triphosphate (ATP) for energy transfer; sulfur, for certain proteins; and very likely others. These elements are going to have to come out of the ambient ocean. And even though they're a small part of the overall biomass, if we're talking a floating *forest*, the absolute amount of stuff that needs to be gathered is enormous—at least relative to the usual concentrations in seawater.

Even Earth's high seas are mostly deserts, too—the highly productive areas are either in shallows, or in places where the currents' vagaries bring nutrients up from deep water. This suggests that shallow oceans, or at least oceans with lots of shallow places, may favor the emergence of floatwood forests, simply because it seems easier to get nu-

² Life As We Know It!

trients up into the surface water. In fact, Hatch even implied that parts of his Okeanos were shallow enough for anchorages. Extremely deep oceans, by contrast, are likely to be nutrient-starved: an extreme example was Lee Goodloe and Jerry Olftion's "Waterworld" (March '94), in which the planet consisted entirely of a vastly deep ocean that in turn was thermally stratified, so that little exchange existed between the (presumably) more nutrient-rich depths and the surface. Perhaps the floatwood trees could get started by growing in shallow water and later break off into a free-floating life as they mature. Tumbleweed³ on Earth does something similar, although the plant breaks free from its taproot only after it's died and is ready to spread its ripened seeds.

Arranging for global *shallow* oceans, or even for oceans with extensive shallow areas, proves to raise a subtle problem, though. On average, Earth's oceans just slightly overfill their basins, and this is not accidental; plate tectonics scrapes continental rock together until it breaches the sea surface. Then erosion tends to keep it trimmed down. (Continental crust is *different*; it's "granite," loosely speaking, and represents material "sweated out" of the mantle by magmatism over geologic time. Since it's too light to go down a subduction zone, it accumulates to form continental crust.)

So just adding water to an Earthlike world, to flood the continental masses, won't work. Over geologic time the continental masses will become higher and the oceans deeper—and the total continental area, whether shallows or land, will become *smaller*.

An alternative is a planet with less active tectonics. Earth's fate will be to become smoother over geologic time as its internal heat sources run down, volcanism dies away, and plate tectonics grinds to a halt (see "Refueling a Rundown

Planet," Aug '91). When that happens, erosion will reign unopposed, and eventually the ocean will sweep unimpeded from pole to pole. This fate would happen sooner to planets that were shorted on their initial complement of long-lived radioactive elements, the heat sources that power a planet over geologic time. Without tectonics or volcanism, too, stirring up nutrients off the bottom becomes even more critical, because then there's no other way to get them back into circulation.

One possible stirring mechanism is waves. Let's look at them. "Wave base," the deepest point stirred by oceanic waves, is roughly half the wavelength of those waves. Again, therefore, shallow oceans will make things easier.

And wave heights (and wavelengths) may well be higher on an all-ocean world, at least sometimes. Three obvious factors control the height of waves raised by the wind: (1) wind speed; (2) wind duration; and (3) the *fetch*, or the distance the wind blows across the sea surface. The biggest factor on an ocean-world is probably the fetch, because both wind and sea would never be blocked or deflected by land. The only part of the present Earth where you can go continuously around the planet at a constant latitude and never encounter land is in the southern ocean around Antarctica. It's not accidental that the seas there, especially in the Drake Passage between South America and Antarctica, are famed as the roughest in the world.

Now, there is a limit to the wave height that can be raised at a given windspeed. For example, a 60-knot gale blowing for 24 hours over a fetch of 500 miles will raise waves about 55 ft high. Storm-raised waves don't die away immediately when the wind does, either; they become the swells you find ocean-wide even in calm weather. On Earth,

³ Which, as it turns out, is *not* native to the American West, but an invader weed from Central Asia!

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most eventually encounter land and dissipate their energy as surf. On an all-ocean world, though, with their paths unblocked by land, they would persist far longer.

This is especially important because the wind's limitations do *not* set the ultimate limit on wave height, due to interaction among waves: the Physics 101 phenomenon of "wave interference." If two wave trains are out of synchronization ("out of phase"), the crests of one matching the troughs of the other, they cancel. This is "destructive" interference. On the other hand, if the wave trains are in phase, they reinforce: The heights become higher, and the troughs deeper. This is *constructive* interference⁴, and it can lead to much larger waves than those that can be raised by the wind alone.

Constructive interference explains "rogue waves," rare ship-swallowing monsters. Occasional waves or wave trains with heights over 100 feet are now well documented, and are no doubt responsible for many mysterious ship disappearances, even in otherwise calm weather, over the years. Ernest Shackleton, in his epic Antarctic voyage, described encountering a rogue wave while traversing the Drake Passage to South Georgia Island. They were probably fortunate to be in a little boat, because even though the very crest broke over them, the boat rode up and over the bulk of the wave.

So, enormous world-circling waves, perhaps even hundreds of feet high like those described in Jordin Kare's fiksong "Waverider," might exist, at least intermittently, on an ocean planet. They would arise from constructive interference among wave trains raised by different large storms. And they'd be very good at stirring up the sea bottom, at least in places.

Of course, they could also be a hazard to a floatwood forest! Since the forest

would presumably be flexible, though, it could follow the contours of the sea surface and thus, like Shackleton's boat, largely ride up and over even mountainous waves. Perhaps, too, the occasional storm-driven breakup of floatwood forests would be a *de facto* reproduction mechanism. The dispersed smaller pieces of forest could simply grow into new forests, like terrestrial plants taking root from cuttings.

Ocean currents are another stirring mechanism. Fundamentally, they're driven by the tendency for heat to flow from the tropics to the poles, but there are several distinct mechanisms and lots of complications. Winds can drive currents—and on an ocean unblocked by any land, the patterns overall should be simpler than on Earth. On a rapidly spinning planet like the Earth, the Coriolis effect also deflects both oceanic and atmospheric flows.

A less well-known mechanism is *thermohaline circulation*: vertical overturn in the oceans driven by density differences resulting from temperature or salinity. On the Earth, it's dominated by cold, denser water sinking at the poles and flowing back at depth toward the equator, while warm equatorial surface water spreads poleward. (This is the reason that the deep sea is cold, by the way.) An all-ocean planet may well have no polar ice, though, because heat transfer from the equator is too efficient. Certainly the Earth has had none at many times in the geologic past, when the continents were differently distributed.

In the absence of ice-cold water, though, salinity differences can still drive overturn. Warm equatorial water becomes saltier and denser, and sinks. We see this happening on a small scale on the modern Earth: The Mediterranean loses more water to evaporation than it receives from the rivers feeding its basin. The sea surface thus becomes more saline and sinks to form a relatively

⁴ Only a physicist could come up with a term like "constructive" interference!

Table 1.

Earthlike temperature levels in other Solar System atmospheres

	P (bars)	T (°C)	g	Atmosphere composition	MW	Notes.
Venus	0.53	29.2	0.91	CO ₂ (95%), N ₂ (5%)	43.2	55 km above surface
Jupiter	5.5	26.9	2.65	H ₂ (88%), He (12%)	2.2	Equiv. depth = 145'
Saturn	8.6	26.9	1.13	ditto	ditto	Equiv. depth = 245'
Uranus	65	26.9	0.92	ditto	ditto	Equiv. depth = 2060'
Neptune	65	26.9	1.16	ditto	ditto	Equiv. depth = 2060'

P is pressure: 1 bar = 10 newtons/cm² = 0.986923 atmospheres = 100,000 pascals. "g" is surface gravity, Earth = 1. Only major components shown in atmosphere composition; outer planet composition assumed from solar. Percentages are by volume. "MW" is average molecular weight. Venus data from the Venus reference atmosphere (Advances in Space Research, 5, 1986); outer planet data from Hubbard (1984, p. 273). "Equiv. depth" is the depth corresponding to the pressure in Earth's oceans.

warm, salty current that flows at depth out through the Strait of Gibraltar. A relatively cooler, fresher current flows in from the open Atlantic to compensate. Something similar will surely happen even without icecaps and should also help in stirring the sea.

Ocean run w/vu, no prop tx

Well, of course if floating habitats haven't evolved anywhere naturally, that shouldn't stop us. We can build 'em instead! They certainly seem safer and more robust—even granted the big waves and occasional great storms—than seabed(!) habitats, a staple of 1950s SF. Huge undersea bubbles, holding back the ocean—give me a hurricane instead any day!

Marshall Savage, of course, has proposed floathabs on Earth as a "dry run" for space colonization. These would be great floating cities that would grow their own food, and would power themselves using the thermal gradient between warm surface water and deep cold water—"Ocean thermal energy conversion," or OTEC. If you take the *long* view, too, such floathabs will be a "wet" run for habitats on all-ocean planets, on which there won't be any alternative.

As far as that goes, permanent seagoing habitats seem to be happening now.

Some cruise ships are being converted to condos! Time will tell whether this is a passing fad or a step toward actual floathabs.

A last point, though, is that floathabs on the Earth seem highly vulnerable to attack by other humans, particularly with the disturbing and unexpected return of piracy on parts of the high seas. And, of course, if conflict should escalate to full-scale military action, a floathab is—almost literally—a sitting duck.

Which means maybe we should look elsewhere for building them. Since oceanic worlds around other stars aren't going to be available for a while, what other alternatives might there be?

So who needs an ocean anyway?

Where's the most Earthlike off-Earth environment in the *real* Solar System? It's on Venus.

What? After I've just made fun of all those old wet-Venus stories?

Well, maybe not exactly *on* Venus, as on the surface. It's up in the atmosphere. Some 55 km above the Venusian surface, the temperature at the equator is a pleasant 29°C (80°F)—and the ambient pressure is about half a terrestrial atmosphere (Table 1). Recently, Geoffrey A. Landis and Mitchell Burn-

side Clapp—both well known in the aerospace and SF communities—have proposed putting floating habitats there, in essence, giant balloons. Landis in particular notes two key advantages over a space colony: The colony is shielded from solar and cosmic radiation, just as the Earth's atmosphere shields the surface, and it will automatically have near-Earth-normal gravity. Hence there's no Hobson's choice between an indefinite zero-g environment, or a massive engineering investment to arrange a spinning habitat. (Landis also notes that Venus's real problem is just that its surface is so far below the 1-bar level . . .)

Atmospheric Venus habitats also have been used in Sarah Zettel's novel *The Quiet Invasion* and Bob Buckley's *World in the Clouds* (March-May '80). Zettel's and Buckley's stories, though, had people making expeditions to the surface in special protective gear, which I find implausible. Almost certainly, surface expeditions, for exploration or mining or whatever, will be carried out using telepresence instead. It's likely to be a lot cheaper, as well as vastly safer.

But let's look at the hab itself. When I wrote "balloon," your mental image was probably of a living space suspended below a vast bulbous bag containing the lifting gas. Think of the little cabin under a blimp. That seems hazardous indeed! Even if we think of the Venus atmosphere as an "ocean," which is probably justified by its density as well as its mass, it seems hazardous. Sinking in a water ocean would be bad enough, but at least it doesn't parboil you, too.

Fortunately that mental image is completely wrong. The habitat isn't *supported* by a balloon, it *is* the balloon. The reason is that ordinary air is lighter than

Venus air, so it's a lifting gas in the Venus atmosphere. In fact, the lifting power of air on Venus is 55% of that of helium in Earth's atmosphere!⁵ Zettel implied such a hab in her story, but Buckley proposed helium buoyancy chambers, which aren't necessary.

There are a couple of potential problems, though. First, 55 km off the ground is right in the middle of Venus's "zonal retrograde superrotation," a layer of perennial winds that circle Venus completely in about 4 Earth days. They spin in the same direction as Venus rotates, but considerably faster. At the equator the windspeed is about 60 meters per second, or 134 mph—the speed of a Category 4 hurricane. Still, that's not the problem it seems. As long as the flow is reasonably smooth, you don't care what your airspeed is with respect to the surface. It won't be like bouncing around in a permanent Katrina! And it has an advantage: Landis points out that riding Venus's superrotation gives a day-night cycle that is considerably more convenient than the 4 *months* experienced on the surface.

There will be bumps occasionally, though. There is some wind shear in the vicinity, particularly around the 46–48 km level, and Pioneer Venus photos suggested that there are also local convection cells near the subsolar point. Perhaps the habs will try to stay in middle latitudes instead, to avoid passing directly under the Sun. This would also have the advantage that the temperature would be lower near the 1-bar level. Alternatively, maybe they just batten down the hatches every four days when they cross at high noon!

Now for the second problem: the 55-km height is also *right* in the middle

⁵ The lifting power of a balloon is proportional to the difference between the molecular weights of the gas inside versus that outside. Air has a molecular weight of about 29; that of Venus's atmosphere is about 43.2 (Table 1), for a difference of 14.2. Helium (He) has a molecular weight of 4, so the relative lifting power of He in air is $29-4$, or 25. And $14.2/25 \sim 55\%$.

of the main cloud deck, which extends from roughly 45 to 70 km above the surface.

This probably isn't a showstopper either, though. There's a widespread misconception that the Venus clouds are very thick. They aren't: by terrestrial standards they're extremely thin, mere haze or smog rather than "clouds." Even at their thickest the visibility is a few kilometers. They're opaque when seen from the outside only because they're dozens of kilometers deep.

So, at least the hab wouldn't be floating through perpetual fog, although it certainly messes up stargazing out of the upper deck. Maybe airborne excursions up to the top of the cloud layer will be popular. During daylight it would probably look like a very smoggy sky in L.A., although the sky would be more yellowish than brown. That's another problem: The clouds are made of micron-sized droplets of sulfuric acid, so the hab will have to be made of corrosion-resistant material. Carbon composites, fabricated directly from the CO_2 , should work fine. Solar power should also be eminently practical, as the sky will be very bright.

Elsewhere ("Diamond Ether, Nanotechnology, and Venus," Nov '99) I've talked about Venus's long-term value as a source of carbon, the "ultimate material" of molecular nanotechnology. After all, its atmosphere is the biggest off-Earth carbon reservoir in the Inner System. I proposed nanobugs that would convert CO_2 into a solid polymorph, "carba," that could be gathered up more conveniently for offworld shipment⁶. Ultimately, too, after a few thousand years Venus would be terraformed as a by-product, as the bulk of her atmosphere was removed.

I think we now know where the carba miners are going to live.

Other atmospheres?

Many years ago, Poul Anderson wrote a story ("Brake," Aug '57) about a derelict spaceship that took refuge in Jupiter's atmosphere. The ship had a sturdy enough hull that it could float deep within the atmosphere while waiting for rescue.

So what, then, about floating habitats on the outer planets?

Unfortunately, they don't look too promising. Jupiter, of course, is a bad bet for long-term habitation, without even looking at other problems, because of its 2.6-g surface gravity—barring major gengineering of the human organism. But even Saturn, Uranus, and Neptune have serious problems, despite their nearly Earthlike gravities (Table 1).

First, the "room temperature" level corresponds to pressures well above one atmosphere—equivalent to over 2000 ft down in Earth's ocean, in the case of Uranus and Neptune. Now, this isn't completely a showstopper: The habs could be filled with a helium-oxygen mixture, instead of air, as is done with divers making extremely deep forays in Earth's oceans. It does complicate things, though.

More important, the atmospheric compositions are roughly solar: hydrogen with some helium mixed in. Even a helium-oxygen mixture, although much less dense than ordinary air, will be denser than that! So these habs *cannot* support themselves just with the buoyancy of their contained air. They will need to be supported by separate buoyancy chambers, at a substantial cost in both complexity and safety.

Even more important, the atmospheres of these planets are highly turbulent. Look at the seething zones and belts on Jupiter! At the very least a hab will be buffeted around unmercifully, and at worst it will be carried down into the hotter, higher-pressure zones below to be destroyed. It doesn't look good for

⁶ Carba has since been synthesized, but alas, the current version is only stable under extreme pressure!

Poul's story, either, even ignoring the turbulence. At the 100-bar level, where the spaceship was to have floated, the temperature in the real Jupiter has already risen to some 440°C.

The outer planets may be good sites for scientific stations—populated by AIs, perhaps!—but I don't see permanent settlements by biological humans.

And elsewhere?

The discovery (finally!) of planets around other stars broadens the potential playing field quite a bit, especially since it may well be that Earthlike planets are much rarer than we'd thought (see "Just How Average Is the Solar System?", Sept '97). However, the "hot Jupiters" that have been discovered—massive planets orbiting extremely close to their parent stars, closer than Mercury is to the Sun—look to be even worse bets for floathabs than our own giant planets. For one thing, unless a planet is a reasonable distance from its star, there *is* no temperate level. Temperatures go from merely very hot at the outer part of the atmosphere to *extremely* hot inside. Even Venus is cold out at the edge of its atmosphere—that's why there's a room-temperature level farther down. Second, if the planets' atmospheres are largely hydrogen and helium, as seems to be the case, the buoyancy problem becomes even worse. Hot hydrogen and helium are even less dense than cold! Any gas, of course, becomes less dense if its pressure is held constant while its temperature is raised.

However, I suspect that Venus-type worlds might be fairly common in the Universe. As opposed to Earths (i.e., planets supporting liquid water), which may well require a fairly stringent set of initial conditions, it seems easy to make

a Venus. All you need is a planet, fairly close to its star, whose gravity is low enough that it can't keep hydrogen but high enough to keep heavier gases. Since it's hot, all the CO₂ and H₂O stay in the atmosphere, so the CO₂ doesn't get safely precipitated out into limestone, as has happened on Earth⁷. Then the H₂O is split up over geologic time by incoming ultraviolet (UV) light ("photodissociation"), with the hydrogen escaping to space. Voila! A Venus.

I have trouble coming up with any reasonable scenarios for other heavier-than-air atmospheres, though. Carbon and oxygen are both abundant heavy elements, so CO₂ is common. It's pretty benign, too. Sulfur dioxide might well be a major atmospheric component somewhere (Io would have an SO₂ atmosphere if it were bigger), but it's both reactive and toxic (see "Fire, Brimstone, and Maybe Life?", July '90). To dismiss another possibility, hydrocarbons are too vulnerable to photodissociation to be reasonable as major atmospheric constituents on close-in planets. They'd have some serious flammability issues for oxygen-containing habs, too! Finally, although other heavy gases exist, they're made up of rare elements and so seem unlikely as major atmospheric components. Sulfur hexafluoride, SF₆, for example, is very heavy (molecular weight = 146!) and (surprisingly) nontoxic⁸. Fluorine, however, is a very rare element, some ten thousand times less abundant than oxygen (see "Those Halogen Breathers," Oct '84).

Settling the Universe in Venus-style floathabs, and presumably slowly terraforming the host planet in the process, hasn't been an element in SF, so far as I know. But maybe it will make up one part of the interstellar diaspora. ■

⁷ Earth has just as much CO₂ as Venus does; the difference is we're standing on it.

⁸ Although UV photochemistry from the parent star might make small amounts of some seriously nasty compounds like S₂F₁₀.

Acknowledgments

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Till recently Steve Gillett was a research professor at the Mackay School of Mines, University of Nevada, Reno, where he'd worked on Paleozoic paleomagnetism, lunar resources, and seismic risk at Yucca Mountain, Nevada, the proposed high-level nuclear waste repository. He also taught intro geology classes including one on planetary geology. He is now involved in several start-up ventures on applications of nanotechnology in environment and resources. He has a white paper on this topic online at the Foresight Institute (www.foresight.org). Gillett has a B.S. in geology from Caltech and a Ph.D. from SUNY Stony Brook.

IN TIMES TO COME

If you're reading this, you're probably familiar with "Clarke's Law," stating that "Any sufficiently advanced technology is indistinguishable from magic." In "Emerald River, Pearl Sky," the lead novella for our January/February double issue (with a Bob Eggleton cover), Rajnar Vajra takes you to a future in which that takes on a new kind of truth. It's a colorful, flashy, weird place that might first make you think you're reading fantasy—but if you know Vajra, you'll know he has something up his sleeve. I won't tell you just what, but I will say it includes an exhilarating dose of solid entertaining, as well as a sobering thought for our time. . . .

We'll have two quite different fact articles: one on why the poles might be good places for lunar settlements and how they might be shielded against radiation, and one by Richard A. Lovett on how we might adapt to running out of oil—including one option you probably haven't heard much about. Lovett also has a special feature on writing about things you're not familiar with, plus a short story. That last is just one of an unusually diverse collection of fiction, also featuring stories by such writers as Kristine Kathryn Rusch, Carl Frederick, Grey Rollins, Jerry Olton, and Stephen L. Burns. And, last but far from least, we'll have the conclusion of Robert J. Sawyer's novel, *Rollback*.

Double Dead

Grey Rollins

Copies of ourselves, of whatever sort,
could have all kinds of uses. . . .

The door was open, of course. It usually is. It's cooler that way. Sometimes, if I'm lucky, the secretary from the lawyer's office down the hall stops to talk to me. She's a divorced mother of two, working for an ambulance chaser. She makes just enough to pay someone else to watch her children and buy food. It's a precarious existence, treading the fine line between getting by and going broke. I've loaned her small amounts of money from time to time, but never been repaid. She sometimes seems to be hinting that she'd like me to ask her out. I've never been able to decide whether she's interested in me or looking for a currency donor. It's not acceptable for a man to ask that question. Not out loud; not even in the silence of his own mind. Women can wonder whether a man is only interested in sex, but if a man dares question a woman's motives, lightning bolts smite the infidel who dared question her intentions. Never doubt that double standards still exist.

Not having a client and not having the secretary to talk to at the moment, I was

reading a novel. Granted, it's not the recommended thing. When a client comes in, you're supposed to be squinting at a hastily scrawled note written by a dying man, or cleaning your gun. Also acceptable is romancing a beautiful woman, but only if it's her husband who's about to come through the door. Otherwise the frisson of danger is lost and it doesn't play properly in the noir school of detective work.

"Ahem," came the delicate cough from my doorway.

I looked up . . . and froze in astonishment. The beautiful woman had arrived and was leaning casually against my doorframe. The fantasy developed quickly in my mind: the significant look, a little quick repartee, the first hesitant kiss . . . I opened my mouth to utter the requisite witty—

"*Dinos in the Dark?*" she inquired, her head canted slightly to read the title of my book. "Let me guess . . . your favorite author is T. Rex Stout, right?"

"Emily Brontesaurus, actually," I said. This was not at all the way things were supposed to go. I gave her a mock

scornful look. "You're late. I finished cleaning my gun an hour ago. That was the cue for your grand entrance."

She nodded her head once, the hint of a smile on her lips. "Good save." She stepped into my office. "I'm—"

"Amanda McBey," I finished for her, saving her the trouble of an entirely superfluous introduction. Her most recent picture had been a bit of a disappointment, but no one, no matter how jaded or cynical, was counting her career as over. She was just entering her twenty-ninth year and had every right to expect the next ten years of her life to handily eclipse the success of the last ten.

"And you're Jack Sawyer," she said, completing the symmetry of our introductions. "You come highly recommended. Your handling of the John Holland case made quite an impression in certain circles." She slid into my visitor's chair with the unstudied grace of a panther.

I slipped *Dinos* into a desk drawer . . . discretely, I hoped. "So what can I do for you, Ms. McBey?"

She gave me a sly smile. "I liked the honesty of having the book out on the desk. Now you're trying to clean up your first impression."

"You've got an eye for detail. If you ever need another career, you'd be a natural as a detective." This was empty banter on my part and we both knew it. Amanda McBey needed a job as a detective the way she needed termites in her forty-seven-room bungalow up in the hills. If all else failed, she could go back to being a model, that being how she got her start. Her looks were often likened to those of a sexually mature elf. It was those ungodly, slightly tilted, blue-gray eyes that did it. Mere mortal women aren't granted eyes such as those. Nor, short of selling their souls, are they granted bodies like the one perched in my visitor's chair.

She was gracious enough to laugh, perhaps even in genuine amusement. "If it's any consolation, I read the book." She leaned forward and whispered conspira-

torially, "And liked it, too . . . but if you ever tell anyone that, I'll call you a liar."

"Your secret is safe with me." I leaned back in my chair and steeped my fingers. "I could sit here and talk to you for the rest of the my life, but the ring on your finger tells me I would be ill-advised to ask you to dinner. Besides, I'm not wearing my tux, silly me, so I doubt they'd let me into The Orchard or Ernie's or wherever the elite eat these days."

"Funny you should mention my ring—"

"Ah, the plot thickens," I said.

She gave me a small smile. "You knew it had to, sooner or later. It's like this; my husband didn't come home Thursday night. His publicist has a cover story ready to go as soon as the media find out, but so far we've been lucky."

"Let's see . . . this is Tuesday, so—"

"Before you start down that road, let me complicate matters a bit. They found his body late yesterday."

My stomach dropped along with my jaw. "Oh, I'm so sorry. I shouldn't have—"

She shook her head. "No need to apologize, Mr. Sawyer. You didn't know, and it will be held under wraps for as long as possible to give you time to look into the case, because, you see . . . he isn't *really* dead."

"The woman is beautiful. The woman is rich. The woman has more sex appeal clad in a burlap sack than a platoon of Playmates in lingerie. So why are you acting like a spoiled child who didn't find what he wanted under the Christmas tree?" my terminal demanded. "You're a real pain when you're like this, you know."

I glared at the terminal, seeing my own image staring back at me. "I'll remind you of that the next time you throw a tantrum," I said.

"I," he said loftily, "don't throw tantrums. I left all that behind me when I ascended to a higher plane of existence."

I recoiled with a twisted face. "High-

er plane of existence? What, you've become a Buddhist? If you're an example of what I have to look forward to in my next incarnation, I'll stick to the traditional live-till-you-die plan and turn out the lights when it's time to go."

"Buddy, I am your next incarnation," he pointed out acidly. "It's just that, through some oversight on the part of the Great Network In The Sky, you were allowed another chance to adjust your karma. Those of us who know you personally could have told the Grand Poo-Bah it was a waste of time, but there's no telling the gods anything."

There was more than a grain of truth in what he said, which made it difficult to refute his logic. Once upon a time, I had been killed. Rather messily murdered, in fact. Fortunately, I had a recent personality backup in the network. Had things progressed normally, I would have had a new body grown, been read into that body, and rejoined the living, thereby exchanging my chance to play a harp for the dubious privilege of worrying about rent and other sundry mundane topics. But, as fate would have it, there had been a slight detour on the way back to my current body—I had been awoken within the computer network. It's not an unknown thing, just rare due to the expense involved. The cusp came when I managed to make a copy of myself while still in the system. Now I was back in flesh, while my dopelganger resided within the network. This was beyond rare. To our knowledge, the situation was unique and quite possibly illegal. As such, his existence was kept a secret, lest he get his plug pulled.

All this talk about being on a higher plane of existence was sour grapes on his part; a poorly disguised lament for the fact that he no longer had taste buds or hormones. That simple fact didn't interfere with his memory of better times, though, and at the moment he was stealing glances at my glass of Brora.

I took an ostentatious sip, closed my

eyes, and savored the taste of the scotch as it tickled my taste buds with memories of malted barley luxuriating in peat smoke. "Abh," I sighed, just to rub it in.

"You are rude, crude, and socially unacceptable," he spat angrily. "One of these days I'm going to be sitting where you are with a glass of Highland Park in my hand and you're going to regret this."

"Tell you what," I said. "I'll do a personality backup tonight before I go to bed, and you'll get the fresh memory. I'll even go so far as to throw in what I can remember of the steak dinner I had Saturday night for free."

"All this and secondhand Amanda McBey, too," he snarled. "What more could a guy ask for?"

"It's not like I kissed her or anything," I protested. "All I did was look at her."

"Looking at Amanda McBey is more nourishing than actual intimacy with most women. She's about as close to perfection as I can imagine, and believe me, I've become quite the expert in imagining—seeing as how it's all I've got."

I gave him a rueful look. "Fantasy is all we're going to get, I'm afraid. No matter how charming I am, I am simply hired help."

My counterpart heaved a theatrical sigh. "All right, all right. I surrender. Beggars can't be choosers and all that. Just get me that personality backup, okay? I don't want the passage of time to dull your recollection of details."

"Well, if it's details you want . . . her skirt was black and came to right about here—"

"Stop! Stop!" he screamed. "I don't want to know any more. You're a fiend from hell, did you know that?"

"You should know. You're me."

"Don't remind me," he grouched. "What do we have to do to make Amanda forget the chasm between our respective social strata and fall in love with us?"

"Solve the case, I imagine. The story goes like this—her husband, Ian Hielsby, went to a charity auction this past Thursday night. He left the house just after din-

ner, about seven thirty or eight. No one paid attention because they didn't know that it was going to matter."

"Thursday night, eh? And now, with my vastly superior intellect, I stretch forth my hand, seeking information on auctions this past Thursday night and . . . lo, it appears. I assume that this was the Lakewood Children's Home auction?"

"Yep."

"Got it. It started at eight. Given the distance from their place to the site where the auction was being held, I'd estimate that he would have had to leave closer to seven fifteen if he wanted to get there on time."

That's what my software twin brings to the table. He can scrounge information instantly. My role is to do the things that require physical presence. I nodded. "Sounds good to me. Anyway, he got there, shook hands and schmoozed with all the right people, put in a few token bids—"

"They raised one point eight million, it says here," he put in.

"And left around ten thirty. He got in the car, drove off, and was never seen again."

"Until . . ." he prompted.

"Until his car was found crushed against a boulder at the bottom of a ravine."

"The body was somewhat the worse for wear, I take it."

"Severe physical trauma and burns," I said.

"Ugh," he said, "Okay, you win this round. I'm glad I'm not a real human at this particular moment. I don't mind having left nausea behind when I came to live in here."

"Yeah, well, this is where the plot thickens. Amanda doesn't think it's him, or at least not the real him."

Computers being able to think much faster than flesh and blood, he was on that like a wolf on a rabbit. "Amanda thinks the body was a clone."

I nodded. "Exactly."

"Any evidence to support this, or is it

just the latest way to enter denial that your loved one is really dead?"

"Nothing you could hang your hat on, but there's this one nagging little detail."

"Yes . . . ?" he responded, right on cue.

"She thinks that Hielsby has been in contact with his old high-school sweetheart."

"Oh, ho! Now, that *is* interesting," my alter ego said. "Okay, so, the death was staged, is that it?"

"That's what she thinks. And since she's already paid for two weeks in advance, we're thinking that way, too."

"Gotcha," he said. "Our job is to investigate the possibility that he's run off with an old flame. What do the police say?"

"They say that the DNA matches and there's no sign that Hielsby withdrew money from the bank, packed a suitcase, or did any of the things you might expect someone to do."

He frowned. "All that does is rule out the possibility that he's a complete idiot. Anyone with an ounce of sense would know that the cops would check that sort of thing. If you're going to skip out and don't care who knows it, then, fine, raid the piggy bank, but if you want to slip away without anyone being the wiser, you'd be well advised to do it carefully," he said.

"If Amanda's right and her husband has left, then he's off to a good start," I pointed out.

"If she's right, we're dealing with a cold-hearted man. Anyone who can kill a perfectly good clone that way is inhuman."

Given that my twin and I have more than the average interest in the well-being of clones, that observation gave me shivers. "You're suggesting that he might take a similarly cavalier attitude toward our lives?" I asked.

The image in the terminal nodded. "Make sure you do an absolutely complete personality backup tonight before you go to bed." He started to shut down for the evening, then popped back up. "Oh, and while you're at it, go over the Amanda parts twice."

I gave him a reproachful look. "Thou shalt not covet thy neighbor's wife," I reminded him.

"We're not neighbors, so that doesn't apply. Lust away, lad." And he was gone.

The next morning started badly. I banged my little toe on a chair leg and spent the next five minutes inventing new ways to curse. Then I dropped a bowl and broke it. In the process of picking up the broken glass, I cut my hand. Needless to say, I was in a rare mood when I finally headed out the door.

From the comparative safety of the computer terminal, my double said, "You know, on days like today, being in here doesn't seem so bad after all."

I turned slowly and gave him a glower that would have withered a flesh-and-blood human. "The way things are going, I may end up in there whether I want to or not."

"Plenty of room," he noted conversationally. "And you've got a fresh personality backup. A nice one, at that."

Rather than reply, I slammed the door shut, cutting off further conversation.

The drive to the office was no worse than usual—it just seemed that way. The usual percentage of cars cut in front of me, but my attitude toward their drivers was decidedly more hostile. By the time I parked and got out of the car, I had grudgingly come to the realization that I was a menace to society in general and myself in particular. Unfortunately, that only made things worse.

The note I received from Amanda did nothing to improve my mood. A gossip columnist had caught wind of the fact that Hielsby was missing. Amanda thoughtfully provided a link to the online article. I read it once quickly, then again more slowly. The rudiments were there. The auction. Hielsby departing. The car at the bottom of the ravine. But the take was he was dead, i.e., the superficial story. It went on from there to the usual hand-wringing about the grief-

stricken wife.

Obviously, she wasn't describing the Amanda I'd met. While not exactly a merry widow, she was far from grieving.

Trial and error has produced a system where my doppelganger stays away from the office. Don't get me wrong, it would be nice to have someone to talk to on slow days, but having him around both at work and at home is a little too much of a good thing. We find ourselves bickering and arguing, and life quickly becomes miserable for both of us. Besides, given that he's supposed to keep a low profile, we can't talk much. Having him at the apartment suited both of us better. Granted, he could "be" anywhere in the world that there was a computer, but we both agreed that it was safer for him to run on a computer that was under our control.

That didn't mean that we never spoke when I was at the office, however. I prodded the button that would summon my twin from the apartment. The journey took milliseconds.

"You rang?" he inquired.

"What if the whole thing's a lie?"

"You mean Amanda?"

"Yeah. What if she arranged the whole scenario just to get rid of Hielsby?"

He turned sour. "I don't like the sound of this."

I said, "Look at the overall arc of the thing for a moment. She didn't shed any tears when she was here. In fact, she was able to joke and chat as though we'd bumped into one another at a dinner party. For a woman who has just—supposedly—lost her husband, that's not a normal reaction."

"Okay . . . so noted."

"She is clearly perceptive, intelligent, and detail oriented. All factors that would work in her favor in planning a caper such as this," I added.

"What does your gut say?"

I paused before shaking my head. "I don't think she did it. But what if I'm wrong?"

He shrugged. "There are about forty

different permutations that we could consider, but I think our best bet for the moment is to take her version of things at face value and earn our money. If we run across anything that doesn't fit, we can reconsider."

I grunted. "Let's hope that things don't go that way. I'd hate to think that Amanda McBey was that evil on the inside."

"Yeah, the classic looker with a heart of mold. That would be a rather effective counterweight to her other charms." He departed. For the moment, the majority of the work was going to fall on him. He needed to track down phone records, vehicle registrations, and look for plane tickets. My job was to scuff some shoe leather trying to locate Lan Hielsby's old girlfriend.

I always get a sense of satisfaction from starting a new case. All things seem possible when the scent of money is in the air. It clears the mind and sharpens the senses in a way that few other motivators can.

The address Amanda McBey had given me for Bettina Harncourt was all the way across town. Bettina hadn't answered her phone earlier, but that didn't necessarily mean anything. My part was to verify the street address, then sit back to watch. In an ideal world, I could simply ask Bettina and she would tell me whether she'd seen Lan recently, but the reality was that I'd have to do some sleuthing to find out whether Lan Hielsby was with her. Unfortunately, if Lan Hielsby was as clever as we thought, it was unlikely that he would spoil such a well-planned disappearance by openly taking up with his old girlfriend in less than a week. Still, one could hope.

I drove past the entrance to the Cedar Ridge development, noting the manned guardhouse. There was even a black steel gate across the road. The guard may have been bored, but he was alert enough to watch me drive past. I'm sure that being checked in and out made the residents of Cedar Ridge feel secure, but

the illusion was shattered by the low split-rail fence surrounding the grounds.

I drove around the perimeter of the neighborhood as slowly as I could without attracting undue attention. I was studying the fence carefully, looking for evidence of infrared beams, cameras, or trip wires. Nothing. Surely they hadn't been that lax about their security. When I was roughly halfway around from the guard kiosk, I parked my car on a side street and walked back to the fence. I actually had one foot on the rail before I saw it—a subtle geometric variation in the growth patterns of the mown grass on the other side. Pressure sensitive plates were buried just beneath the surface of the soil.

Ah, now that was more like it.

All electronic security measures have strengths and weaknesses. Infrared beams are broken by heavy rain. Trip wires are susceptible to wildlife. Pressure plates are best hidden under random surfaces like fallen leaves, but fallen leaves come from trees and trees have a persistent habit of growing roots across the plates, permanently triggering them. The alternative, growing grass over them, is fine as long as you don't mow. Waist-high grass is ideal cover, but completely unacceptable to the residents of upscale residential complexes.

Their loss, my gain.

It takes a very careful work crew to place the sensors in a pattern that can't be penetrated by walking between the plates, so the odds were in my favor if I was patient. Sure enough, I found a break in the pattern not much further along. A particularly handsome oak had grown right where the fence would have gone. Rather than cut the tree, they had rerouted the fence. Predictably, the pattern of the pressure plates had been disrupted. I couldn't count on roots having disabled any particular one of the plates, but at least it tipped the odds in my favor.

I studied the ground for a few minutes, making a mental map of where I

would need to step. It would be tricky, but not impossible. I mounted the fence, stepped gingerly on the ground on the other side, then did a slow-motion ballet to get to the ground beyond the plates. Piece of cake, assuming that no one had happened to notice me tiptoeing oddly through apparently normal grass. Most people do not spend their waking hours staring out the windows on the off chance that a strange man might decide to pirouette under an oak tree just for fun. Even then, they're likely to decide that he's simply a bit daft and turn away rather than race for the phone.

A few minutes later I was doing a brisk walk along the street leading to Bettina's house. I hoped that anyone who saw me would interpret my purposeful stride as being exercise rather than a stealthy approach for nefarious ends. I need not have worried. No one was in their yard, and I was passed by only one car, the driver of which ignored me, falsely confident that intruders couldn't get past the gate.

Bettina Harncourt's place answered a lot of questions, but raised others in their stead. The windows gaped, the curtains gone. A quick walk around showed that all the rooms were empty, just bare walls and carpet with indentations where the furniture had been.

Getting back to my car revealed a complication in the guise of a guard dog. He came in low, fast, and silent, and the only thing that saved me was that I was already nearly to the fence. Throwing caution to the wind, I ran straight across the plates, vaulted the fence, feeling a snap at my calf as my right leg left the ground. The dog, fortunately, was trained to stay within the fence—nonetheless, I sprinted all the way back to the car, burning adrenaline all the way.

I elected to go back to the apartment instead of the office. The dog's teeth had punctured my pants leg and I want-

ed a few minutes of peace and quiet to calm down. It wouldn't hurt to see how things were going on other fronts.

"No blood drawn, I take it?" the terminal said.

I shook my head. "No, just a pair of pants ruined."

"Did anyone see you?"

"Only the guy in the car and people in our income bracket are invisible to him."

"And no guards caught you?"

I shook my head. "I was back in the car within ninety seconds of hitting the pressure plates—in motion ten seconds after that—John Q. Citizen going about his lawful business."

The image in the terminal nodded. "Good, good. All right, we'll assume that the pressure plates are set to something like one hundred pounds. They wouldn't normally go off if the dog stepped on them, but the force of the dog jumping might do it. With luck, they'll assume that the dog chased a squirrel up the tree, then bounced around a few times barking at it."

"Somehow I think the dog will have been trained not to chase squirrels, but as long as they didn't see me, it's a moot point."

"Onward and upward, then," he said.

"It looks as though Bettina Harncourt has flown the coop. It doesn't prove anything, but it certainly is suggestive."

"The question is, where did she go?" I asked.

"Forwarded mail," he suggested. "The post office will have her new address."

"But—"

"I'm already on it. It'll take a bit for me to find a way into the computer system at the post office, though; they seem to have put up a nontrivial barrier."

"Surely she told at least one friend where she was going. The problem is that by the time we discover the identity of her two hundred closest and most personal friends and rummage through their address books, I'll be rivaling Methuselah for oldest man."

"And given the way the day is going, the address won't be entered into anything I can hack; it'll be scribbled on a scrap of paper pegged to someone's refrigerator door with a magnet," he added helpfully.

"You're not helping matters," I grouched.

"Hey, look on the bright side: you found out that she's moved. We no longer have to hammer her phone trying to catch her at home."

"Found her cell phone number yet?"

He shook his head. "Not yet."

"It won't . . . wait a minute . . . what if she used it to call Amanda's house? You might be able to backtrack from there."

He nodded in approval. "So flesh and blood does sometimes manage to squeeze out a useful idea."

"I'll ask Amanda if she can give us any idea when a suspicious phone call might have come in. Otherwise, we're going to spend weeks tracking all sorts of innocuous calls coming from her agent, her thirty best friends, the florist—"

"The butcher, the baker, and the candlestick maker . . . I get the idea. And as icing on the cake, you get to see Herself."

"The thought had crossed my mind," I admitted modestly.

"You are incorrigible."

I sighed happily, leaning back and lacing my fingers behind my head. "Yeah, ain't it great?"

As fate would have it, Amanda was able to make time for me that afternoon. Given the way the day had started, I wouldn't have bet on anything less than a month's delay. She had been scheduled for an interview from two o'clock until three, but had cancelled, pleading that she needed time alone after the death of her husband. The question was where to meet. The major news services had her house staked out, along with a horde of paparazzi, so my going there was out of the question. Let them get one hint of a detective and it would be

splashed all over the news within thirty minutes. Setting aside questions of embarrassment, we couldn't afford the risk that Lan might see the news and realize that we were onto him.

Amanda and I could have talked on the phone, but she wanted to get out of the house and didn't trust someone not to be monitoring her phone calls anyway. Landlines can be tapped, and cell-phone calls can be picked up by specialized scanners. Supposedly impenetrable encryption schemes now last, on average, about six months before someone figures out a backdoor.

She had been speaking rather elliptically, but if I had read her intentions properly, she was going to figure out a way to escape, then either call me with instructions or meet me at the office. I didn't waste any time getting from the apartment to the office, although I did take a moment to change trousers.

I was having trouble concentrating on *Dinos in the Dark*, but couldn't quite see myself pacing the floor when Amanda McBey arrived. Bad for my image. On the other hand, reading *Dinos* wasn't exactly going to earn me points, either. To add to the turmoil, I felt angry and stupid for caring how I appeared to her. I grunted, disgusted with myself, and settled behind the desk to read.

Just as the pterodactyl was swooping toward the heroine, my door closed quietly. I looked up just as Amanda McBey turned. "Hi," she said with a smug grin.

I waggled the book at her. "You look good enough to eat."

"Is that a risqué suggestion or are you at one of the exciting parts?"

"Well, if you count blood-curdling screams and bodies being ripped limb from limb, then exciting things happen about three times per chapter. But for me, the best part was when you walked into the room."

And the most unlikely thing happened—she blushed. "Um, well, tell you what . . . put that thought on the shelf.

Don't throw it away, but don't leave it lying around on your desk where the cleaning lady might find it, either."

I'm not stupid. There was no possible way that meant what it sounded like it meant. It was just me reading too much into a perfectly innocent statement. Regardless, the beast within me reared on its hind legs and began to lick its chops.

She took a deep breath and let it out noisily. "Look, I'm in a bit of turmoil emotionally. Either my husband has taken off with this old flame of his, or he's dead. Either way, it's..." She broke off, wiping impatiently at her eyes. "Dammit, I swore to myself I wasn't going to get emotional while I was talking to you. I'll deal with this on my own time." It took a moment for her to regain her composure. "Okay, I can do this. It's just acting, right? And acting is what I'm good at. I can act like I'm calm and collected for at least twenty minutes... can't I?" She closed her eyes and took a deep, shuddering breath. "All right, where do we stand?"

The flash of pure, visceral emotion was beyond acting. "I understand, Amanda," I said quietly. "It's only been twenty-four hours, but I do have some news. I've verified that Bettina Harncourt has moved. Her furniture is gone and there's no sign that she intends to come back. Granted, that's not proof that she is involved in your husband's disappearance, but it's worth noting. In the meantime, I was wondering if you could give me even a guess as to when Bettina might have called your husband. We need to find out where she's gone if we're going to discover whether your husband is with her. There are several possible ways that we can do this, but this is an important one."

She gave me a humorless smile and leaned back in the seat, staring at the ceiling. "There was a call about a week—no, wait, it was the day after I talked with Henry about the part in *Sunflowers*, so that would have been... have you got a calendar?"

I handed her a small giveaway one from the bank, which I kept in a drawer.

"Let me see, that would have been on..." her finger traced across the dates; "the eighteenth. It was just before we ate, so that would have been around six thirty or seven."

I nodded. "Excellent. Are there any others you can remember?"

"There was another call that I was suspicious of this past Monday. That one would have been around one o'clock."

"Afternoon, I hope," I said.

She smiled briefly. "Yes, afternoon. Even Bettina wouldn't be so crass as to call at one in the morning."

"Any others?"

"Probably half a dozen or so, but I didn't write them down, and the dates and times are long gone. Sorry."

I shook my head. "Don't be. You've done well giving me these two. This will give me an extra avenue to explore." I made notes on a pad, then looked back up at her. "Is there anything else you can think of that might help? I know we went through several things yesterday, but has anything else occurred to you?"

"Lan always wanted to live at the beach. I remembered that last night. I don't know if he would pick now to act on it, but it's a possibility."

I made another note. "Good... now, assuming that he's actually run off, the chances are that he's not going to react well to being found. He's gone to a lot of trouble to lay a false trail, and if it doesn't work, he may do something foolish."

"Are you saying that he might hurt someone if you confront him?" she asked.

I grimaced. "Actually, I'd rather not confront him at all. I'd rather let the police handle that part. If he's done what we suspect he's done, then he's guilty of reproductive cloning, and that's a serious crime. He'll be arrested and face trial."

"Not a good career move," she observed wryly.

"I think he's pretty much decided to

make a clean break with his past life. Under the circumstances; I don't think he could go back to acting even if he wanted to."

We talked for a little while longer, but didn't arrive at any brilliant conclusions. When she stood to go, I asked, "Amanda, I need to ask this, even though you don't want to hear it."

She turned back to me. "What is it?"

"Will you be all right if it turns out that Ian didn't run off?"

"You mean if he's really dead?"

I nodded.

"I wouldn't have to be mad at him anymore, I guess, but the pain of losing him . . . would be . . ." She shook her head and turned away, swallowing hard. "I'd look like a fool, wouldn't I?"

"Not to me."

She sniffed and wiped at her nose with the back of her hand. "And me without a tissue. I must look like a hag."

That was good. Any man between the ages of nine and ninety would tell you that she was the most genetically perfect woman who had ever lived. A few tears and a little streaked mascara couldn't change that. I handed her a tissue. "If anyone calls you a hag, I'll set them straight."

"You're sweet," she said, then stood on tiptoes and kissed me softly on the cheek.

I reached up and rubbed the spot where she'd kissed me. "I'll never wash that cheek again."

She gave an uneven giggle. "You'd get kind of grubby after a while, wouldn't you?"

"You're worth it," I assured her.

She gave me a rueful look. "I've got to get out of here. You're making me think crazy thoughts."

"Will you be able to get back to your house safely?"

"No, but that's part of my plan. I'm going to mess up my hair and wear glasses and stuff, then go check into a Holiday Inn out on the Interstate. No one will believe that Amanda McBey would stay

there, so I'll be safe as long as I pay cash."

"But—" I began.

She shook her head. "I can't stay at the house. You have no idea what it's like with the paparazzi staring in your windows with telephoto lenses. I hate them. It was a hoot to sneak away, and now that I'm out, I'm going to stay out. They don't even know I'm gone yet, so they'll stay camped out at my house. If they're there and I'm somewhere else, I can have the jitters and not have to worry about an ugly picture popping up on the front of some stupid tabloid."

"How did you get out, anyway?"

"Leanne—she's my secretary—snuck me out under some clothes in her car. They surrounded her and wouldn't let her leave until she said something. She rolled down the window and told them that she was taking clothes to the cleaners. They pestered her about how I was taking it, and she snapped, 'Well, how do you think she's taking it?' Just threw it back in their faces. I was under the clothes, and I could hear everything. It was wonderful."

"So how are you getting around?"

"I'm using her car for the time being. The next time she comes out, she'll bring me one of mine."

"Don't. They'll be looking for your license plates. Just keep driving hers, and let her drive yours all over town. It'll drive 'em crazy."

She gave me another peck on the cheek and left. Personally, I've never quite figured out what Shakespeare meant about parting . . . there's nothing sweet about it—it's all sorrow.

"She *kissed* you?"

"Well . . . yeah, I guess that's what they call it. You know, that thing where they pucker up their lips and—"

"I'm never going to speak to you again!"

I shrugged offhandedly. "Then I guess you don't want to hear what she said afterward." With a great show of noncha-

lance, I walked over to the cabinet and pulled out the bottle of Lagavulin. I could almost hear his circuits fizzing and popping as the pressure built within his silicon innards.

"All right," he ground out. "What did she say?"

"Good-bye."

"What? You're going somewhere?" he demanded.

"No, that's what *she* said. 'Good-bye.' She was leaving. That's what people usually say when they're leaving."

My software double has a better vocabulary than I do. In addition, he has access to every online dictionary in the world, in every language, and can get to them instantly. For the next ten minutes or so, he treated me to an extraordinary round the world tour of scatological terms that would have curled our mother's hair, and as far as I could tell he did not repeat himself once. To say he was a trifle put out with me would have been an understatement.

On the other hand, I couldn't say that I blamed him. In fact, he was taking it better than I would have. After he had expressed himself properly, we got down to business.

"I want you to know that I haven't forgiven you," he muttered. "But I'm trapped in here, so I can't punch you in the nose—something you oh-so-richly deserve at this particular instant."

"As soon as I get you a new backup, we'll be even—both of us will be dealing with memories—which is all I've got at the moment."

He uttered an unprintable oath. "And that's supposed to make me feel better?"

"Feeling good, my digital brother, has absolutely nothing to do with this. If there were any logic to this at all, I wouldn't even have been kissed. As it is, we'll have to be satisfied with being among the few people who know where she's hiding. Besides . . . it was only a puny little chaste sort of kiss, not the face-swallowing sort where you have to get married afterward."

I followed that with the details she had given me when she called back later in the afternoon to tell me where she was staying. I also gave him the information about the suspicious calls she had received.

"Good, I'll get to work on that right away. Now, are you ready for my report?"

"Go for it."

"I thought about it and it seemed logical to me that Lan would need a car. After all, he sacrificed his to the boulder gods and will need some new method of transportation."

"Right. That still leaves begging the question of how he got away from the accident scene, but for the time being, we'll just assume that Bettina was there to give him a lift. So what did you find?"

He looked grim. "Nothing yet. I've been cracking into new car registrations on the state level and even wormed into a few of the nearby car dealerships. I'm working outward in concentric circles, but as the circle gets larger it's taking more and more time to check."

"And you still won't find him if he's got a new identity."

"True, *buuut* . . ." He drew out the word, begging me to ask.

"Okay, I'll bite. What did you find?"

"It's not a purchase, nor is it a registration, but I did find a note in a salesman's computer at a dealership east of town that Lan Hielsby had been looking at a new sports car there just five weeks ago. That's prior to the crash, mind you. He just might have been anticipating the need for a new vehicle."

"The salesman keeps a log of people who look at new cars?"

His image shrugged. "It's one of these things where the dealership has a policy of calling back to see if you're still interested, had any questions, that sort of thing."

I refused to let myself get hopeful, but I had to ask. "And this entry . . . did it happen to have an address or phone number where Lan could be located?"

He nodded. "It did, but at that time he

was giving his home address—the one where Amanda lives.”

“I guess that would have been too easy. Still, it’s interesting, to say the very least, to think that he was considering a new car recently.”

“I’d file it under Circumstantial Evidence, but as you say, it’s interesting. And, yes, before you ask, I’ve put priority on that make and model and others in its class in my search.”

“Pardon me while I put on my devil’s advocate hat, but any lawyer worth his salt would say that Ian simply had money burning a hole in his pocket and wanted to buy a sixth or seventh car or whatever. After all, people like him aren’t limited to a single vehicle like us mere mortals.”

“I agree,” he said. “It’s just an idea. It may pan out. It may not. As you pointed out, if he’s adopted a new identity, then I’ll miss the new registration, but it’s worth looking into.”

A thought occurred to me. “While you’re chasing electrons out there in cyber land, let me toss another possibility out for consideration.”

“And that is?”

“All that furniture from Bettina’s place didn’t levitate. It was moved by human muscle. See if you can find a moving company or a truck rental in the last couple of weeks related to the move.”

His eyes widened. “Oooh! I like it. Score another one for flesh and blood. I’ll spawn off a process to sniff that one out.”

“No luck on house purchases, rentals, hotels—”

He was shaking his head before I’d even finished the list. “Do you have any idea what you’re asking? Let’s say that they lit out of town the night of the accident. Assume that they drove until dawn so as to put as much distance between them and the local investigation as possible. Just in round terms, let’s say that’s about eight hours. Then assume that they stuck to the speed limit and didn’t stop for anything other than filling up

the car. That still gives them a driving range of roughly five hundred miles. Do you have any idea how much area that covers? And that’s assuming that they didn’t keep going when they got up later that next day. Like the car search, it’s going to take some time. I’ve checked all the easy things nearby, but it’s getting slower as I move further away, simply as a matter of pure numbers of possibilities that have to be checked. To simplify things, I’m focused on the major routes out of town. I’ll go back and check secondary routes later.”

“Forwarded mail?”

He shook his head again. “I still haven’t gotten into the mail computer system. I’m not omnipotent, you know.”

I shrugged. “You can’t have everything. Besides, even then it may just turn out that they’re holding her mail as though she’s on vacation or something. And she just might have decided to change her identity, too.”

“And if Ian is changing his identity, he’s not going to care what happens to old-identity bills and such. He’ll let Amanda deal with that little headache.”

“Hmmm. Good point. Remind me to ask Amanda to go over any mail that comes in. There might be a credit card bill that shows a recent purchase that might be worthwhile,” I said.

“This is tedious, but it’s what we’re getting paid to do.”

“And we need that money. Rent is due at the end of next week,” I agreed.

Lan’s autopsy, something we had a particular interest in, had already been done so that the funeral could be scheduled. The officials were interested in things like whether alcohol was involved in the crash, but we were more curious about whether there were any calluses on his hands and feet, scars, fillings in his teeth—the sort of thing that would indicate whether the body had ever been used. A clone, when it is decanted from the vat, is in physically perfect condition, subject only to the limita-

tions of the DNA used to grow it. It's never had a broken bone, never been subjected to any real stress other than an automatic regimen to develop the musculature to a level sufficient for the clone to stand and move around without undue trouble. It's a completely new start, physically.

I knew this from personal experience, having had to deal with my virgin body after being reincarnated. The glitch in my right knee was gone, as was the permanent ringing in my ears from too much loud music in my teens, but I'd been so uncoordinated that it had taken me an entire afternoon to relearn something as simple as how to snap my fingers. My mind knew how, but my new body didn't.

In this case, Lan's clone wouldn't need to exhibit any particular physical ability, since its only job was to be convincingly dead. Given the fact that the body was mutilated, the more subtle physical clues would very likely have been obliterated. And if the cops weren't looking for evidence of foul play they might ignore it even if the coroner did happen to find something that looked a little off. Dental records might work in our favor, but we had not yet heard whether the jaws had survived the crash. If they hadn't, then one of our best bets for proving that the dead Lan was a clone was kaput. Even if the jaw had survived, it still didn't prove anything one way or another since the dead Lan could be the old one, and the live one could be the fresh clone. The law was a little hazy, but if a clone was initiated before the death of the original, it was generally considered reproductive cloning and was against the law. To stay on the right side of the law, you had to die and have a backup of your personality read into the clone. Applications could be made for an exception to the rules, but they were rarely granted.

My job at this point was to reinfiltrate Bettina's old neighborhood and talk to the people on her street. This time I'd

be moving in the open, since I wasn't trying to sneak up on an unsuspecting Bettina. I'd already called and made an appointment with the couple that lived across the street. That would give me a legitimate reason to get past the guard.

The afternoon sun was low in the western sky and golden-red light spilled across the perfectly mown lawns. Each leaf on each tree fairly glowed with healthy vigor. It was so perfect it looked like a photo from an advertising brochure. Much better than my previous visit. Gorgeous, in fact. I was filled with envy. Nothing would do except to beg, borrow, or steal enough money to buy a house in the neighborhood. And I happened to know that one was available right across the street from where I was parked.

The illusion lasted until I opened my car door and heard the unnatural velvety silence. No hum of insects, no laughter of children, nothing. I made a mental note never to move anywhere where nature can't find a toehold. Leave the place to those who are phobic about reality. I prefer real dirt to the sort that doesn't even soil gardeners' gloves.

The door I knocked on looked so antiseptically clean you could eat off of it. The woman who answered wasn't quite as perky as I feared, but her husband, who arrived the perfect 3.7-second interval afterward, made up for it. He was a living, breathing throwback to a 1950s sitcom, complete with comfy sweater.

"My name is Sawyer . . . Jack Sawyer. I called earlier about your neighbor across the street, Bettina Harncourt."

"Yes, yes, I remember," the woman chirped. "I'm Jill, and this is my husband Ted . . . Vaughn, that is. Please, come in."

I stepped inside and instantly figured out why husband-Ted was wearing a sweater. It was frigid inside the house. The outside temperature was somewhere in the vicinity of 90 degrees, yet the air-conditioner was running full-out to provide Ted an excuse to wear his sweater. Or perhaps it was that cold to

accommodate Jill, and he wore the sweater as a defensive measure. Either way, it was odd.

As soon as we were seated in the immaculate living room, Jill bounced back to her feet and announced that she was off to the kitchen to get drinks and what would I like and oh she thought she had cola and tea and lemonade and water of course but if I wanted anything with alcohol in it she would leave me in Ted's capable hands because she always either over-mixed or under-mixed the drinks but he always got it just right and wouldn't I like a martini because they were Ted's specialty and . . .

The verbal onslaught continued until my eyes glazed. I held up a hand and requested water in self-defense. I told myself that she was just nervous, but I didn't really believe it. Somehow I was certain that this was simply the way she was, take it or leave it.

Once the drink portion of our conversation had been properly dealt with, I took a dutiful sip of my water and said, "Thanks. That's just the thing for a hot day." It came out sounding like a cliché. I took another sip and reflected that if I wasn't careful I was going to be dragged into their retro time warp. We would then sit and trade perfectly innocuous platitudes until it was time for me to go, and we would part at the door, telling each other what a nice time we'd had and we'd have to get together and do it again sometime and—I gritted my teeth and forced out the words that I had come here to say. "As I said on the phone, I'm trying to find Bettina Harn-cort. She seems to have left town rather suddenly, and we wanted to make sure that everything was okay."

They both gave simultaneous nods, but neither said anything. Their faces were unmarred by anything approaching human emotion. If Bettina's departure concerned them in the least, it didn't show.

"Did you know Bettina?" I asked.

Wrong question. They both immedi-

ately launched into a matched set of his and hers monologues about what a fine neighbor Bettina had been and how you couldn't ask for a better person, and so forth. After the first two or three sentences, it was painfully clear that neither of them had a clue whether Bettina liked water, lemonade, or martinis. Reading between the lines, I gathered that their idea of a good neighbor was one who never did anything unexpected or loud, and since Bettina had apparently done neither during her tenure as their neighbor, she was A-OK in their books.

I asked if they had ever seen a man across the street. They both glanced at each other before Jill answered with a slight frown. "But Bettina lived alone. I thought you knew that."

"There seems to be at least the possibility that a man came into her life recently."

Jill's frown deepened, approaching open disapproval. "I'm sure I wouldn't know about that. We don't pry into our neighbors' lives, you see."

I was beginning to see the lay of the land, but decided to give it one more try. "Did you happen to notice anything when she moved out?"

They shook their heads as one. I believed them. They lived a cosseted existence, insulated from harsh realities. The neighborhood enclave was a safe nest for them, where the fears of the outside world need not intrude. Indeed, the only thing they feared was fear itself, because the real world could not touch them.

Or so they thought. I wondered what they would say if I told them just how easy it was to get past their guard and right up to their very house. But that would be cruel and pointless. Let them live their fantasy.

I left as quickly as possible. I paused on their front porch, trying to decide what to do next. I was in no hurry to move for the simple reason that the heat felt wonderful as it seeped into my bones, driving away the chill of the freezing house. After standing there a

minute, I got an itchy feeling in the back of my neck and decided that I'd better move on. The Vaughns might not feel comfortable with me, a stranger, standing on their front porch.

Crossing their yard, I decided to visit their neighbor to the left. The house was situated nearly as ideally to observe Bettina's house as the Vaughn's was. Not having called ahead, I didn't know what sort of reception I would receive, but it was worth a try.

There was no answer when I rang the doorbell. I turned and surveyed the curve of the street. The next house along on that side could see Bettina's house, but only just. My next best bet appeared to be the house across the street, Bettina's next-door neighbor.

The woman who answered the door was not cast in the same mould as Jill Vaughn. She looked somewhat out of place. There wasn't any one thing I could put my finger on, but even before she spoke she seemed more centered, more in contact with objective reality.

"Yes?" She fixed me with a very direct gaze.

I'd planned on starting with some light chitchat to try to put her at ease before I started asking questions. Her eyes dared me to try it. I changed tactics. "I'm trying to locate Bettina Harncourt. She seems to have moved suddenly, and it's possible that she's in trouble."

At this point her eyes should have gone vague as she retreated into her memory to remember that Bettina lived next door and to quickly scan all available memories to see if she could figure out what sort of trouble Bettina might have gotten herself into. That didn't happen. Her eyes stayed locked on me. "What sort of trouble?"

"A man seems to have entered her life, and he may not be on the up and up," I told her.

"Did Bettina give you notice that she was leaving?"

"No."

"Then maybe she didn't think it was

any of your damned business," she said sharply.

"Under normal circumstances, it wouldn't be. But if the man has committed murder, then the rules of the game change quickly. She may be in danger, herself."

She'd fired a warning shot at me and I'd fired one back. Now that we'd staked out our positions, the next move was up to her.

Something subtle changed in her face. "If Bettina has a new man in her life, then good for her. It's not for you or me to decide who she should spend her time with."

"Your position is admirably clear." I pulled a card out of my pocket and handed it to her. "If by some chance you happen to hear from her, tell her that Jack Sawyer would like a word with her. Thanks for your time." I turned and stepped off the porch, headed for my car. It's easier said than done, but there are times when it's better to end a losing conversation on your terms rather than let the other party continue to defy you.

Before I'd even gotten halfway across the yard, I had my phone out, dialing my twin. "Yeah?" he began.

"Bettina has a neighbor to the left of her house. The street address is . . ." I looked back over my shoulder at the mailbox and gave him the address, "Do everything you can to get on the phones for that house. Do it immediately. Unless I miss my guess, the woman I just spoke with is going to call Bettina very quickly, indeed. Find out where that call goes, and we will know where Bettina is."

"So you have kicked the proverbial hornet's nest," he observed.

"I hope so, yes. It's clear this woman knows Bettina and knows at least some of what has happened."

"But not all."

"I don't think so. I more or less accused Ian of murder. It rocked her. She almost decided to talk to me, but decided to remain loyal to Bettina. If I'm right, she'll try to get in contact with Bettina

to ask her what the hell is going on."

"And to tell her that there's a stranger asking pointed questions about her."

"That, too," I said.

"I'm on it," he said, and hung up.

My retreat from Cedar Ridge was clean and efficient. I even waved politely at the guard sweating in his kiosk on the way out. He had air-conditioning, but it was unable to compete with the open door where he leaned out to speak with visitors. The man was suffering for his paycheck, and I sympathized with him.

I had seen the guard dog trotting through the woods on the way out of the neighborhood. Some primal part of me wanted to kill the misbegotten creature, but the more rational portion of my mind recognized that he didn't bear me any personal animosity; it was just business.

That didn't mean that I was overcome with sufficient warm fuzzies to want to adopt the little monster.

The afternoon sun was just above the horizon. The combination of the direct rays and the reflection from the hood of my car was making my retinas smolder. I couldn't wait to get somewhere quieter and much, much dimmer. As if that wasn't enough, my stomach was starting to complain.

I wasn't even halfway home when my double called me.

"I," he informed me archly, "performed perfectly. *She*, on the other hand, took her damned time making up her mind to call Bettina."

"It's about time something went right," I growled.

"My sentiments exactly. Not only do I have the number she called, I have a recording of the call itself."

"That's illegal," I pointed out.

"And tracing the call isn't?" he replied caustically.

"Point taken," I said. "So where do we stand?"

"Where are you now?"

"Give me a second, there's a mile

marker coming up . . . okay, I've just passed marker ninety-three, westbound."

"Take the next exit and start making your way south. I'll fine tune you as you go."

"Is Lan with her?" I demanded.

"You and I both know that there are no certainties in this business, but I'll give you multiple nines percent probability that he is."

"I can live with those odds," I told him as I slowed for the exit ramp.

Surveillance is an uncomfortable business. Particularly in temperature extremes when you can't sit there with the engine running to power the heat, or in this case, the air-conditioning. I could feel sweat tickling down my ribs. Everything stuck to me—my shirt, my pants, the seat, even the door I was leaning against to keep from falling over. My face was melting. I could feel it dribbling off my chin. I was convinced that if I looked down, I'd see streams of molten flesh, looking not unlike runs of wax down the side of a candle.

Being a private investigator isn't as glamorous as the movies make it seem.

The Wayfarer Inn was the kind of place that made my apartment look upscale. Bettina—and hopefully Lan—had adopted the same cheap and anonymous tactic that Amanda was using. They had only driven about an hour—long enough to get to a rundown little town comprised of aging, middle-class residential neighborhoods, pawnshops, and questionable car-repair joints.

I was keeping an eye on a dark green sedan, second from the end, to make sure they didn't escape. We had confirmed that it was Bettina's car. Other than that, matters were out of my hands for the moment. My only function was to observe.

The door to room twenty-six popped open, and a woman appeared in the doorway. I assumed that it was Bettina, since she was the only woman we knew to be staying in the room, but I had not

seen a picture of her and couldn't make positive ID. She turned back, facing into the room, obviously greatly agitated. Her mouth was moving, but I couldn't hear anything. It was obviously emotional, though. She finished her say and turned to stomp to the car.

She hit the remote and the trunk came unlatched, swinging half open. She snatched at the lid, flinging it fully open. The trunk, in the perverse way of inanimate objects, bounced off the stops and hit her on the head as she leaned in to deposit the clothes bag she'd been carrying.

I didn't need to hear the words to know what she said then. The pantomime was clear enough even from my distance. She grabbed the back of her head with both hands, dropping the garment bag in the process. The bag slumped onto the tarry asphalt, which set off a new round of cursing on her part, though she continued to hold her head.

Being preoccupied with her, I'd missed Lan Hielsby coming out the door. He pulled her hands from her head to look at the wounded area. She slapped his hands away and pushed blindly at him, causing him to stagger back a few feet.

I had my phone propped on the dash, camera aimed so as to cover both the room and car. "Bingo! Dead men walk. Are you catching this?" I asked.

"Looks like there's trouble in paradise," my twin observed. "Wish we could have heard what she was saying."

"We're just observers at the moment," I reminded him. "Flies on the wall."

"Flies that need better hearing," he grumbled.

"I still wish you could have gotten into the terminal in the room."

He sighed. "They've had it turned off. I can't do anything without electrons. For that matter, I still haven't gotten into the computer at the post office. Looks like we've bypassed the need for that, though."

Lan was clearly pleading with Bettina, but she was backing away from him. He made a grab for her just as a car rounded the corner of the building and screeched to a halt right behind Bettina.

"Okay, that's our cue," I said, pushing open the door of the car.

I sprinted towards the action at top speed, but was not fast enough to catch Amanda, who had bounded from her car headed straight for Lan. She was on him in a flash, clawing at his face. Lan was built big and clearly spent a fair portion of his time at the gym maintaining his physique, but he was unequal to the task of defending himself against the fury being unleashed against him. He fell backward, striking his head on the curb.

I grabbed Amanda from behind in time to keep her from kicking him. "Whoa, girl, whoa . . . he's gotten the message. You don't want to be dragged in on an assault charge."

She sagged backward against my chest, panting for breath. "I'm going to kill him," she growled.

"That won't be necessary," Bettina said in a dangerously quiet voice as she stepped past us and delivered a kick that would have shamed a mule. "I'll do the job."

Still circling Amanda with my left arm, I reached out and took Bettina's shoulder with my right hand just as she was cocking her leg for another kick. "He's down. He's not going anywhere. There are three of us and one of him. We can restrain him until the police get here."

Bettina turned and looked at Amanda. "We've both been fools, but I've been the bigger one. I'm sorry. I should not have interfered in your relationship; but it happened in such small steps that I didn't realize that things were out of control until it was too late." Her gaze shifted to me. "You're the detective? Sawyer?"

"Yes."

She looked sideways at Lan, her eyes filled with tears. She shook her head. "Damn. How'd I get myself into

such a mess?"

Lan made a faint noise. I could feel Amanda's muscles twitch as she started to go to him, then held herself back.

Bettina saw, too. She gave a bitter snort. "Yeah, me too. At this moment, I don't really care if he lives or dies."

At that moment, with the combined hatred of two women weighing on him, I did not envy Lan Hielsby in the least.

"In some ways, it would have been more merciful if Lan had died," I said.

"He got what he deserved," my counterpart observed. "He got a concussion, faces charges for his part in reproductive cloning, and a separate charge of murder for killing the clone. Serious stuff, that. On top of that, he's got to endure a very messy, very public divorce in which he was clearly the bad guy."

"Both women came out looking good," I observed.

He snorted. "Amanda McBey *always* looks good."

"Bettina Harncourt, for all the fact that she was Lan Hielsby's high-school sweetheart, has lived an ordinary life up until now. That's changing rapidly. She's been offered a very healthy sum of money for a book on her part in the story. I'm sure her heart was broken, but it seems as though she going to come out okay."

"If the gossip is true, she's been seeing Martin Bosen, so she's got a rich, good-looking, A-list boyfriend."

I laughed out loud. "Oh, there's one thing for sure . . . she will not lack for candidates to choose from. Every man on the planet has this little secret question in the back of his mind—what has Bettina Harncourt got that could drag a man away from Amanda McBey? And they're dying to find out."

"It's probably not much consolation to her at the moment, but Amanda's free of that idiot," he said, "and has the sympathy of nearly every man, woman, and child. Advance reviews of her next movie look good. In fact, if she could only get her love life straightened out,

she'd—"

The phone rang. I picked it up. "Hello?"

"Jack, it's Amanda. I wanted to thank you for doing such a good job on this thing with Lan. It was a little painful and all, but that's not your fault. In fact, I was talking to Kyle Tattersall this morning and he said he may have a little problem you can help him with."

"Isn't he the one that got the Emmy last year?"

"That's him. Anyway, I gave him your number."

"Well, thanks, I appreciate that."

"Um, look, Jack, can I ask a favor?"

"Sure."

"The paparazzi are driving me crazy. This thing with Lan has driven them into a feeding frenzy, and they're crawling through the bushes around my house with cameras and recorders and all sorts of gadgets. I was wondering . . . would it be okay if I came to see you? I'm tired of this whole celebrity aura thing, and I'd just like to spend some time with someone who isn't trying to interview me or trying to get me to read his script. And I thought of you, because I wouldn't have to explain this whole Lan situation to you since you already know everything, and we could just act like real people for a change."

The expression on my software double's face was priceless. Being nothing more than pixels, he could manipulate his image at will. At the moment, his jaw was dropped so far it looked comically unhinged, his eyes were the size of saucers, and a little text ticker was running across the bottom of the screen: I HATE YOU . . . DON'T BLOW THIS . . . I HATE YOU . . . DON'T BLOW THIS . . .

I leaned back into the cushions and said comfortably, "Amanda, I'd like nothing better." ■

(EDITOR'S NOTE: Jack Sawyer and his "Doppelganger" previously appeared in "Or Die Trying" [February 2001] and "Death As a Way of Life" [May 2005].)



Illustrated by
Vincent Di Fate

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OPENS HOT

Craig DeLancey

Competition has
often been a stimulus
to achievement—
but sometimes the prize
is just a step to
something bigger.



"No no no no no no no no no no no no no no," T.J. said. "No. Penguin, no. Just no."

"T.J., they're in trouble," I said to her in as steady a voice as I could manage. Sweat stained my rumpled flight suit even though it was so cold in the capsule now that our breath clouded as we talked, floating this way and that in the microgravity. I envied T.J. her ability to have a crisp, ready-to-fly appearance at all times.

"This is Cutter we're talking about, right? The weapons developer who called Openshot a threat to human destiny?"

I sighed. "This is serious, T.J. Steven Frazier is dead. Cutter and Caldrige are coasting in a decaying orbit. They may be unable to make the exit burn properly."

"Bad situation," Zen muttered. Zen held a cable bundle in his hands—he was always holding something in his hands, working on it, even during take-off—but he looked at T.J., then at me, with his lips pursed, a slight frown on his wide brow. Zen was our lead engineer, a great, placid bear of a man from New Zealand, and a slightly furrowed brow was the closest he usually came to an emotional display. I was our systems expert. I'm instead a global motley, like the Openshot program itself: my mother's Danish, my father's a second-generation Swede of African descent, and I was raised in Berkeley.

T.J. hesitated. Everyone thought Frazier was a good man. If things had worked out a very little bit differently, he might have been a member of Openshot. Finally, she said, with an exasperated tone that conveyed little sympathy for the stranded team, "Look, I'm not saying we shouldn't help them. Even though this is Cutter's team, I say okay, let's help them. But they're relatively stable now, not losing air or power or fuel, right? So, we should land, win this contest, and then help them."

"We don't know what we might need to solve this," I said. "We could end up

needing the fuel in our landing module. Or some of its parts."

T.J. narrowed her green eyes. "Hey, speaking of landing modules: you're talking about their command, their orbiting module—that's what's busted, right? Cutter's landing module is okay?"

I nodded.

"So what's keeping them from landing on the Moon?"

"Insufficient crew," Zen said.

"No," T.J. growled. "Cutter would land alone. It could be done."

"Well," I said. "They know they might need the landing module thrust for their orbit ascent, even for transearth injection—though it doesn't have enough juice for that. Because right now their orbiting module is dead."

T.J. scowled and changed tactics. "We're halfway to the Moon, damn it." She pointed at the small, triangular window behind her, making her long hair swing a wide sweep through the air as she spun quickly to face it. She was agile in space. She had lost both her legs from the knees down when she crashed some junk heap of a test stealth plane four years before, and in microgravity she ditched her artificial legs and moved through the ship fast and light. Legs just got in the way in space, though her superiors at NASA had not seen it that way.

The window was opaque from condensation, and there was a fine filigree of ice outside, but the faint glow of Luna shone through. "The other teams are months behind us. Only Cutter is in front of us. We can come in first and get the prize money. One hundred million dollars to get Openshot out of the red. To prove Openshot was right—isn't that what you dreamed, Penguin? And the Moon—we can be the first to walk there on our own steam. We're not going to get another chance to be the first to return. Let's walk and then help them."

It was a good pitch. T.J. supports Openshot, but she mostly just wants to win, to prove to NASA and all those people like Cutter who discounted her that

she could fly still and fly better than them. But she knew that Openshot was my life's passion. Yet: the numbers were inexorable. I sighed again. "It is safer for everyone if we help them before we attempt any other maneuvers. Now, I've thought it out," I held up my PDA. "And Zen checked and cleaned up my math. They're in our orbital path—"

She couldn't help herself: she burst out, "And why? Because they copied our flight plan. All our plans were public, there on the web, and that bastard Cutter ridiculed us, and then he just copied most of our work and launched three days before us."

"Right, okay," I continued, waving my hands in a placating gesture. 'Most' was an exaggeration, but Cutter's team had definitely copied some of our work. "That's right. So they're in our trajectory. We can dock, use just a little fuel. Then see if we can help. And probably still land, if we don't need the lander. Worst case, we use a joint burn to bring them back. But the landing module can go down and back probably even so."

"I don't like it." She spun in place quickly, to align with Zen. "Zen, surely this is going to reduce our chances to land."

He nodded, but said, "small difference." He inhaled deeply and seemed to relax. Put a machine in front of him, or any technical problem like this one, and he was at peace. Hence the name.

"Ground Control agrees," I added. A monitor on the wall by me showed in two graphs the opinion on the Openshot network. The global members of the Openshot team were voting two to one against helping the Cutter Industries Team before landing, an angry red bar dwarfing a soft green one. But Ground Control was recommending that our ship, the *Stallman*, make the link immediately and attempt to help the stranded team. T.J. frowned at this. That her position was the more popular was no solace. The broader membership of the Openshot program tended to

be a bit flippant, to react too quickly. I liked to compare it to the subcortex, generating your quick but base impulses, and Ground Control instead was like your cortex, filtering and directing those impulses.

Nearly ten thousand people around the world were active participants in the Openshot, an open source engineering project to the Moon. Some were engineers, some scientists, many were amateurs, but they all had devoted their time, and some had given money to the project to join the International Lunar Peace Race to be the first nongovernmental organization to put a person back on the Moon. The prize money had been staked by a consortium of space corporations and governments. In two years, working with open plans posted to the web and vetted through these thousands of participants, Openshot had designed a complete Moon shot. The core Ground Control team, some devoting their entire personal fortunes to the effort, had built the ship.

And nearly all ten thousand Openshot members would be listening now to this debate, albeit with a half a second delay.

I repeated myself softly, speaking only to T.J. "Ground Control agrees, T.J. And it's the right thing. We do this well, and we should still be able to land."

"You don't have what it takes to win," she spat. "You think this is still a hack. We're not hacking here. We're in flight. We're on our way. *We're winning*. And that means the very idea of the Openshot is winning. But you can't see that."

Silence hung for a moment. Then Zen said, "The right thing."

"Oh, use a damn verb, will you, Zen."

I cringed, but Zen just mumbled, "Not necessary."

T.J. turned, prepared to push out of the room, through the open hatch and into the landing module, to steal the only bit of privacy possible in our ship. But then she stopped in place and turned slowly, an idea clearly dawning on her face. The displays on the walls

ANALOG

were frantically blinking red with dozens of emergency messages from project members around the world, and no doubt many of them were warnings about what she just realized.

"He'll land," she said.

"What?" I asked.

"Cutter. If we announce we're coming to save them, he'll land. He'll figure he doesn't need the landing module's thrust, and he'll land it and be back before we even arrive."

I had to think that over. It was plausible. Cutter was like T.J.: he wanted to win, and he would not be able to think about anything else but winning.

Zen twisted the cable in his hands, and then muttered, "Most likely."

"You tell them we help on one condition only," she said. "We land first. That's it. Anything else and I'll blow the damn safety hatches and cripple us before I'll let you dock with their Command Module. I'd do it."

"Most likely," Zen repeated.

I nodded very slowly. I didn't want to make that call—it sounded too much like blackmail to me—but T.J. had a point. "Okay."

"Damn fortunate one of us thinks about these things," she told me. And then she did push off and leave us to handle the mission replanning.

"Hit the burn," I told T.J. It was thirty hours later. Cutter had accepted our terms. We were strapped into our launch couches and had flipped the modules so that the main engine faced Luna. We needed another quick burn to drop us more quickly into our descent orbit where we could match up with the Cutter Team. Earth shone bright blue through the streaked condensation on the windows before us. Condensation was really getting to be a problem, and all the walls of the module had a sweaty sheen on them. The seats we sat in emitted a faint smell of mildew when we pressed ourselves into them.

"Hit the burn," I repeated.

The *Stallman* was built on Russian surplus, a prototype module for the D.O.A. second phase of Space Station Freedom. Like all four teams attempting the race, the Openshot had used an Apollo approach, with separate landing and command modules. Rules allowed commercial transport to and from Earth orbit, so no team bothered with an Earth landing module. Our Lunar landing module was docked onto one end of the Russian module, and an engine stack was locked onto the other. But there were two side hatches, part of the space station build-as-you-go methodology meant to allow linking of several similar modules. We would use one of these to link with the Cutter Team's command ship.

We were helmeted, which was safety procedure for any burn, and I watched stats from Ground Control as they projected across my visor. But after the silence stretched on, I looked over at T.J. My shoulders turned awkwardly as I bent forward so that she could see me through the narrow view of my helmet. Green lights played in pale faded writing across T.J.'s face. Her hand hesitated over the ignition switch.

"If you don't burn now we might overshoot," I whispered.

"Yeah, Penguin, I was thinking just that," she said. And then she slapped the switch. A dull roar filled the ship. We waited until the onboard computer cut the fuel.

"Good burn," Zen said.

"Sorry to hear that," T.J. told him without looking up.

We spun our ship ninety degrees, letting Luna loom and then fill our view. We talked only over the necessary preparations, watching the ancient companion of Earth in silence the rest of the time, until after two hours Zen said, "There it is," and pointed out of the small window.

Floating a kilometer before us was the Cutter Team's ship, just visible in hard bright contrast against the dark gray of

the shadowed Moon beyond.

It was a long white cylinder, built from scratch but otherwise not much unlike our own ship in size. It had only a single docking hatch, though, and so they had removed their landing module to free it up so we could dock. After a moment scanning the scene, I saw their lander, a black and gray sphere with six legs, drifting two hundred meters off. They had tethered it to the ship, I think, but no line was visible to the naked eye. It looked safely distant.

"Tricky," Zen said.

"Right," T.J. told us. "It's going take skill to bring this thing in sideways and dock to that dog of theirs. So you two better be nice to me. It's bad enough that my heart ain't in it."

"Right," Zen and I both said cautiously.

She did it, of course. Our docking hatches slapped together hard when we finally drifted in for the clasp, but the armatures took hold and we had a lock.

I confirmed the positive seal with Cutter's engineer over radio, but before I finished talking, T.J. unbuckled from her seat and drifted down to the dock. I unbuckled and followed.

"I ain't keen on seeing Cutter, but if anyone is going to face him first it's going to be me," she said, as I drifted next to her.

After a check and a cross check, we slipped our hatch. Nothing seemed to be leaking, and so they opened theirs. In a moment the round top of Cutter's helmet filled the narrow passage. Cutter's helmet was a solid clear dome, like something out of an old 1950s science-fiction painting.

He pushed through and drifted into our ship, then aligned with us. It was crowded with the four of us surrounding the hatch. Our legs and arms bumped as we floated towards and away from each other.

T.J. used a closed line to whisper to me, "God, look at his golf tan. He looks like a carrot." I fought down a smile.

Cutter popped his helmet off. He looked at me, at Zen, at T.J., and then he looked at where T.J.'s legs ended at her knees and she had folded her suit back. After an awkward pause he held his hand out with a hesitant smile. We popped our helmets and I took his hand.

"Austen," he said. "Austen Cutter." He was a thin, lithe man, balding with brown hair. He looked muscular even in the suit.

"People call me Penguin," I said.

He took T.J.'s hand. "Colonel Bianco," she told him.

"Colonel," he nodded. He wrinkled his nose. No doubt our ship stank. I had an unusually bad and persistent case of microgravity flatulence, and our collective skills in microgravity toiletry were completely inept. Plus there was the damn condensation and mildew. Cutter shook hands with Zen. Zen pointed at his helmet.

"Ceramic plastic?" Zen asked. He had a dreamy look in his eye. Cutter smiled proudly and handed it over.

"Bleeding edge materials science," Zen said to T.J. in a tone of awe, as if in reply, when she rolled her eyes at him. "Rigid and hard but not brittle. Cracks but doesn't shatter."

"Two verbs! That was almost a sentence," she told him.

Cutter cleared his throat. "Listen," he said. "I want to thank you for coming to help. I know that you are putting your own mission at risk, and Dave and I appreciate it very much. You've really proved a lot of doubters wrong with your project, and I guess it's fair to say I was one of them, but—"

"Let's see your problem," T.J. cut in. She wasn't about to let him seem the slightest bit human. "Zen here is eager to fix you up and send you on your way safely back to Earth." She yanked the helmet out of Zen's hands and slapped it into Cutter's arms.

Cutter frowned and clenched his jaw. I cringed a bit, knowing that was proba-

bly a hard speech for a man like Cutter to start on and a harder one to have thrown back in his face. His eyes shifted to Zen and then to me, as if assessing whether we wanted to hear him keep talking. I tried to look sympathetic but firm. Finally, he said, "Right. Follow me."

He squeezed into their ship, Zen following. "Colonel Bianco?" I whispered to T.J. as we waited together for our turns to crawl through the airlock. She was four years out of the U.S. Air Force, so the title was a huge stretch. And there weren't any titles like that in Openshot.

"I'll marry Zen before I let that bastard call me T.J." She hissed back. Then she pushed me through the hatch.

It smelled like roses in their ship, to be honest. Maybe with a faint scent of oil. Very good air filters, I guess. And everything was white and clean and dry. It was enough to make a systems engineer feel inadequate about his designs, except for the little fact that they were dead in space and our humble odiferous ship was still working.

Caldridge, Cutter's lead engineer, floated before us. "Hello," he called, and smiled with what looked like genuine relief. "I'm Dave Caldridge."

We knew his bio. MIT PhD in Aerospace E. Navy pilot. We had another round of shaking hands. Then Zen surprised us by saying, "We were damn sorry to hear about Steven." Steven Frazier had been their second in command, and by everyone's estimation, the brains of Cutter's launch. "He was a good man. Smart. Fantastic engineer. Fun to know. Many people will miss him."

Cutter and Caldridge both blinked and swallowed. I nodded. T.J. looked uncomfortable.

After a moment, Zen pointed around the room in what was obviously meant to be a kind of question about their status.

Caldridge cleared his throat. "A fuel line broke," he explained. He pointed at the rear of the ship. "Or maybe a joint in the line cracked. Whichever, it leaked

liquid oxygen through an external panel—" He pointed along the wall, indicating the path of LOX between the hull and interior panels. "And that made some of the seals brittle. A backup oxygen tank blew, cracked the hull, and we had a decompression." He finished by pointing at a large black patch on the wall, where it appeared they had covered a hole with a big equivalent of the patch from a bicycle repair kit. "Steven was killed in the depressurization. Austen got his helmet on and then he got mine on me—I was out cold—but Steven was uncomfortable in his suit and had taken it off and by the time we got it on him and put his helmet on. . . ."

"Sorry," Zen said again. The rest of us nodded.

"Yeah. His body's in the landing module right now." Caldridge pointed at another panel. "We turned the fuel line off at the tank when we figured out the problem, and we could maybe replace the line or joints by scavenging some lines from the landing module. But the hydraulic piping that controls the nozzle cuff broke. One hydraulic line is still good, though, so the cuff is being pressed sideways. If we fired it, it would spin us in a circle."

Zen nodded. "Can't turn off the other hydraulic?"

Caldridge shook his head. "No. The cut-off is behind the panel, and when we started to open the panel, when we just cracked it, it was full of oil that got everywhere. The stuff can gum up the air filters. We need a way to suck up the hydraulic fluid, and we didn't bring any paper towels."

"Depressurize and open the panel?" T.J. asked.

"I wanted to," Cutter said. "And we were going to, before we thought to contact you. But. . . ." He looked at Caldridge.

"I'm against it," Caldridge explained. "The throttle-control hydraulics are in there also. We could blow those, too, if we open the panel to vacuum. And the

patch in the hull breach is mostly kept in place by internal pressure, and it's the only patch we have that size."

We talked it over. Cutter and T.J. visibly fidgeted while we picked at the details, both of them impatient but not willing to talk to each other while the engineers worked out the possibilities. To me, they were strikingly similar to each other, though I know T.J. would have killed me if I had said that aloud.

I recorded our conversation and posted it in real time to the Openshot network to get engineers around the world working on it, but the problem was clear. They had a bunch of control lines meant to receive minimal exposure to vacuum that were blowing up and would contaminate the ship if we dug through to them. We couldn't fit everyone in the *Stallman*, so we had to be careful and fix the Cutter ship.

After an hour our ground team had a plan. "I've got a first proposal," I said. I had network glasses on and was looking away from them like a blind man as I read messages from Ground Control. "We soak up the oil, then scavenge the hydraulics from your landing module and replace the hydraulics here. If that works, we try the more dangerous repair of the fuel line. We can depressurize the Openshot and leave from there to get to your lander. Then we stay docked, in case your lines blow again. First you burn to both get ascent and first transearth injection, then we flip and we burn to complete transearth injection. We return together."

"And how do you clean the oil up?" Cutter and T.J. asked simultaneously.

"You have to cut your hair off," I told T.J.

"What?"

"What?" Cutter echoed.

"Human hair is very effective at soaking up oil," I told her. "And you're the only one with any hair."

"That's true," she snorted, and made an exaggerated show of looking at Cutter and Caldrige, both of whom had

only little halos over their ears. Caldrige laughed amiably. Zen and I had both shaved our heads just before launch.

"Who had this idea?" she asked.

"Uh," I turned my attention back to the net displays. "A fifteen-year-old girl in Sri Lanka. Her name is Ravijindran Seshadri. She wants to be an aerospace engineer. Her mother owns a hair parlor, and they have long noticed that hair absorbs oils very effectively."

"Anybody tell her she's a threat to human destiny?" T.J. asked. Cutter frowned and started to speak, but T.J. interrupted him.

"Okay, who has scissors?"

"I have a knife," Zen said.

I cut her hair close to her head, and Cutter pulled off his t-shirt, exposing a well-muscled chest, and knotted the sleeves of it to make a kind of bag. I knew that T.J. liked her long hair, but she managed to not even flinch as I hacked away at it.

She asked, "And when are you and I going down, Zen?"

"Can't," Zen said.

"That's right," I told her. "Two have to scavenge their lander—that has to be Zen and Caldrige. They're the engineers."

"We're all engineers," T.J. said with annoyance.

"You know what I mean," I said. There were engineers and then there were astronauts with engineering degrees.

"Okay, so you and I go down while the PhDs tinker."

"We can't expect Cutter to control the orbit module for rendezvous. Those are my systems. They're a little—personalized."

"So we wait. Then Zen goes down with me after all of this is fixed."

"Not good," Zen said. "Undependable." He pointed a thumb toward the patch on the Cutter ship's hull.

T.J. didn't like where this was going.

"I'm going down alone, then."

ANALOG

"No," I said slowly. "It'll have to be with Cutter."

Cutter smiled and tried to look agreeable. "I would be honored. And you and I are pilots, Colonel. We're only in the way here."

She spun to face Cutter. I growled in protest as I had to jump back to ensure I didn't stab her with the knife I'd been cutting her hair with. "We're not sharing the prize," she said to Cutter. "Get that clear."

"Of course not," Cutter said. "The prize is yours. *If* you can land."

"Shit," she said.

"There's a big rock right below you," I told T.J. over radio.

"I see it," T.J. said. "Give me another ten seconds of burn," she told Cutter. The landing module shook, and the roar was clear right through their helmets so that I could hear it in the command module. We had learned from the Apollo missions about how the landing could stir up a lot of dust and had radar on the base of the ship, and I was watching that as T.J. took a visual and fed instructions to Cutter. She peered out of the window and glanced at the two bottom-camera views and held her breath as they drifted past the sharp-looking spire of stone that loomed in the middle of the landing site.

They had dropped smoothly down toward the Lunar surface, burning first the main engine to drive descent and then attitude jets to line them up for landing. The soft gray dust had slowly resolved into different shades and then into a surface shot with shadows as the boulders and smaller craters came into resolution. Cutter chatted away for the first forty-five minutes of descent, running twice through the landing procedures, questioning me on the radio and then T.J. Finally, he tested the waters with T.J. again.

"Listen, I'm sorry if the things I said insulted you."

T.J. snorted. "Openshot is landing, so

what we did puts the lie to everything you said. Right?"

She asked the rhetorical question pointedly, and he couldn't resist answering it. "I never said you couldn't win."

"No," she spat bitterly. "What you said was, and I quote, 'the Open Source Rocket Program'—you couldn't even bother to name Openshot properly—'the Open Source Rocket Program will have a tremendously negative—'"

I couldn't help it: I interjected, "Pernicious."

"A voice from the heavens. Thank you, yes: 'A tremendously pernicious effect on humanity and human destiny by destroying the benefits of privatizing space exploration with an unsustainable—'"

"I did not say unsustainable," Cutter interrupted. "I said 'unscalable.'"

"An unscalable stunt."

"I still believe that your approach isn't scalable. Look, you and I and Penguin want the same things."

"You just want to win."

"Sure. So do you. But I want the human race to go into space. And you can't do that with this kind of model. Space is expensive. Where does the capital come from on your approach? Who pays for it?"

I almost answered over the command line, but T.J. answered first, and to my surprise, she answered clearly and well. "Do the math. Most of the cost of space exploration goes into design. Open source makes design better, and it makes it cheaper, and it makes it safer. That's scalable."

"But you have to make ships!" He said. "Who will—"

"Enough," T.J. interrupted. "You have to fly this ship. So talk philosophy with Penguin when you get back to Earth, and right now just shut up and take orders."

He'd been silent after that, except to answer commands. T.J. had hardly spoken either, grunting answers to questions and mustering English only to correct Cutter. Fortunately, our two landing

procedures were similar—and Cutter had studied ours, as they were public—so we could let him control the landing burn throttle as T.J. surveyed the landing prospects visually.

“Good. That’s it,” she told him. “There’s too much damn dust kicked up now for us to see much else.”

“Radar shows clear range,” I interjected. “Though radar’s not much use at this distance.”

“Just got to hope we’re lucky,” T.J. said. “Drift nicely down. Touch it.” I heard the shudder of thrust. “Okay, again. Again. Wait. Again. We’re there. Get ready for touchdown. Give me two seconds. Right.”

The module trembled as the landing spikes settled into the bright powder. They had a meter per second of speed, some of it lateral, and the lander tilted slightly, as if it wanted to tip, before it fell back and settled.

“Orbital,” T.J. called to me. “The *Stallman* LLM has landed.”

“Luna, congratulations,” I shouted. Zen laughed and howled behind me.

T.J. and Cutter snapped off their seat straps. “Powering down our engines.”

“We have received congratulations from the International Lunar Peace Race Board,” I added, reading the message off my visor. “As soon as there is a moon-walk, Openshot has won the contest.”

I switched my view to full visual through T.J.’s suit cameras and saw that she had opened up full net projection on the inside of her helmet screen, just to see the graphs of communication volume moving through the Openshot net channels. She skimmed a few of the congratulations coming in from members. An engineer in India. A doctor in China. A schoolgirl in France. A former astronaut in Russia.

“Let’s depressurize and walk,” Cutter said.

“Right,” T.J. said. She sounded cheerful. “Let’s.”

She forced a methodical run through the full checklist, and then they vented

the landing module’s atmosphere.

“Command, I’m about to open the hatch.” T.J. reached for the long, heavy red handle of the manual hatch release. Cutter was in her way, crouching between her and the hatch in the cramped quarters of the lander.

“‘Cuse me,” she said.

“No.”

She pulled back, surprised. “What?”

“No. I’m going first.”

“What the hell are you talking about? You can’t possibly think the jury will award you the prize that way.” She pushed him aside and managed to grip the manual release handle and hold on, but he pushed back and wedged himself into the recess of the hatch.

I cut in. “Luna, this is Orbital. Jury rules are clear. It is the landing-module that determines prizewinner. You won’t get anything for walking out there first, Cutter.”

“To hell with the prize,” Cutter said. “I just want to be first. I owe it to Steven. I promised him we’d walk first on the moon. And we got here first.”

“No, you didn’t,” T.J. said. “You got into orbit first.”

“We’d be here already, if you hadn’t blackmailed us.”

“You couldn’t put your lander down because your ship has a shitty design. That’s what the contest is about, you ass.”

Cutter’s voice got calmer. He sounded resolved. “I could have walked here yesterday. And I promised Steven,” he looked pointedly at T.J.’s suit legs, which were filled out now with the prosthetics that she had put back on. “I promised Steven one of us would walk first on the moon on our own two feet.”

There was a long pause.

“You son of a bitch,” T.J. whispered. “Do you realize the whole world is watching you right now, listening to you?” I heard T.J. grunt then, as she grabbed Cutter and tried to pull him out of the recess of the hatch, but she had no leverage and it was impossible. Final

ly, Cutter reached up and pulled the hatch lever down. Behind him, a pale gray glare shone. He backed out onto the ladder.

T.J. held her breath. I switched my view to the outside lateral camera and watched as Cutter leapt from the top of the ladder, as if afraid T.J. was going to reach out and pull him back in if he didn't rush. He landed hard and said, after a grunt, "I return to Earth's moon in memory of Steven Frazier, astronaut."

I switched my view back to inside T.J.'s helmet. She had left the net traffic images playing on her visor, and as she and Cutter had argued the color of the messages had shifted from green to red. I saw there now a long line of messages, bright with urgency tags, with subject lines like, "CUT HIS SUIT!!!" And "RE: HIT THE BASTARD."

"I'm going to kill him," T.J. whispered. With a few violent jerks she pulled the manual hatch release free from the bolt it turned. It was massive, a long steel wrench.

I had override control for all systems, in case someone was hurt and I had to take over. I closed down her net views and her outgoing public lines and then spoke to her, loud, on a private channel. "T.J., listen to me. Listen. Think of what he just did."

"He stole the walk," she whispered. "And I'm going to kill him."

"T.J., he did something we never could. He just revoked the articles of incorporation for space. He just made the most eloquent argument for the Open-shot dream anyone could have made. We got him here using the open source methods, using cooperation and an

open discussion of our challenges. And he had to steal the opportunity from you. Let him go, let him act like he won. Because we just won. We won the money. And more importantly, we won the argument. Open source will have a seat at the table from now on. It will be part of humanity's expansion into space. We won everything we wanted, T.J. *You* won everything."

She said nothing. But she didn't move.

"T.J., leave the wrench, ignore him, walk out there now, and history will say that you were the one who returned. You were the first to prove that space exploration is something everyone can be part of. Go. Prove it. Prove you are the winner."

I was crying now as I said it, the tears clotting awkwardly in my eyes and clinging to my lashes top and bottom after I blinked. Zen had floated up next to me, and he put a hand on my shoulder.

"Prove it," he whispered to her.

T.J. put the handle back onto the hatch bolt, and bent down to peer out at the open white surface of Luna. I returned control to her suit and opened her lines.

She climbed slowly out and descended the steps silently, in reverence. She stood a long time on the last rung, looking out over the soft powder of Earth's primeval twin. Billions of us had longed to walk there, to run there, to set foot upon that tauntingly nearby world. Some few had done it, and now, now, perhaps our return was the first of many returns.

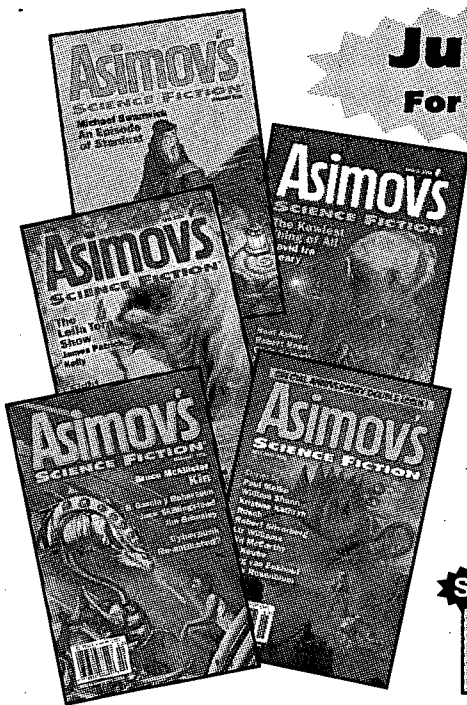
T.J. stepped down on Luna and said, her voice soft but clear, "For everyone." ■

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EPR Communication: Signals from the Future?

Last June I was an invited speaker at the symposium "Frontiers of Time: Reverse Causation—Experiment and Theory," part of a meeting of the American Association for the Advancement of Science (AAAS) held on the beautiful campus of the University of San Diego. (Here, *reverse causation* means a violation of that most mysterious law of physics, the Principle of Causality, which requires that any cause must precede its effects in all reference frames.) I had originally intended to just talk about my work on the transactional interpretation of quantum mechanics and its somewhat retrocausal aspects (i.e., back-in-time handshakes of quantum waves, etc.). However, a new idea involving signaling with nonlocal quantum processes had come my way, and I decided to present it as a retrocausal quantum paradox at the symposium. It made a big splash there, but none of the experts present could identify any problem with the proposed thought experiment or resolve the paradox. In this column I want to tell you about this causality-violating communications scheme and its possible consequences.

Quantum nonlocality was first spotlighted in the famous 1935 "EPR" paper of Einstein, Podolsky, and Rosen, and is now generally acknowledged to be an implicit feature of the standard quantum formalism. In the EPR paper, Einstein and colleagues pointed out that standard quantum mechanics requires enforcement of correlations across spacelike

and negative timelike intervals; that changing something at one end of an extended measurement has consequences at the other end of the measurement, even if the two measurement parts are separated by light years. Einstein referred to such nonlocality as "spooky action-at-a-distance" and took it as evidence of the wrongness of quantum mechanics because such influences would have to propagate faster than light in seeming contradiction to relativity. However, using quantum-entangled particles, many experiments have now shown that the nonlocal aspects of quantum mechanics are real and can be demonstrated in the laboratory in many experimental situations.

One might think that the reality of EPR nonlocality would open up the twin possibilities of faster-than-light and back-in-time communication. However, over the years a number of authors have published "no-signal theorems" demonstrating that such EPR superluminal observer-to-observer communication is impossible within the standard quantum mechanics formalism. Typically, such a formal proof shows that any configuration change at one end of an extended measurement cannot alter what is measured in the other end of the measurement in a way that could be used for signaling.

Recently it has been pointed out, however, that at least some of these proofs are tautological, with their seemingly reasonable assumptions subtly

building in the conclusion, and that key assumptions are inconsistent with some aspects of standard quantum mechanics (e.g., Bose-Einstein symmetrization). Therefore, the door seems to be open at least a crack for the twin possibilities of EPR retro-causal and superluminal signaling between observers.

Last March, my belief in the validity of no-signal theorems was shaken by reading (in German) the PhD thesis of Birgit Dopfer, who received her doctorate from the University of Innsbruck in 1998. She performed an EPR experiment using pairs of momentum-entangled infrared photons, both with wavelengths of 702.2 nm, produced by parametric down-conversion in a nonlinear LiIO_3 crystal pumped with a 351.1 nm ultraviolet laser beam. The twin photon pairs were entangled by momentum conservation, because the two infrared photon momentum vectors must add up to the momentum vector of the ultraviolet photon that produced them. In Dopfer's experiment, the entangled photons, which emerge from the LiIO_3 crystal 56.28° apart in angle and on opposite sides of the pump beam, were routed along two paths that we will refer to as the upper and lower arms.

The photon in the lower arm reaches an opaque plate pierced by two pinholes, and the light that survives to reach the other side is detected by an imaging detector, which produces signals indicating the presence and position of the detected photon. As we will see, this detector may show the position distribution of either a "2-slit interference pattern" structured with sharp peaks and deep valleys, or a "1-slit diffraction pattern," a broad bump without much structure.

The photon in the upper arm of the experiment reaches a lens of focal length f . The lens is positioned such that the sum of the distances from the LiIO_3 crystal to the lower-arm pinholes and to the upper-arm lens together add up to a

total distance of $2f$. Behind the lens is a second imaging detector that detects the photons that have passed through the lens. The lower-arm detector, because of the pinhole apertures, receives many fewer photons than the upper arm detector, but Dopfer recorded events only when both detectors had an arriving photon at the same time, i.e., in coincidence.

The measurements performed with this system can be considered for two cases. In Case 1, the upper-arm detector is placed at a distance $2f$ beyond the lens, while in Case 2, the upper-arm detector is placed at a distance f beyond the lens. Because of the focal properties and position of the lens and the momentum correlation of the two photons, the pinholes encountered by the photon in the lower arm are imaged by the photons in the upper arm at a distance $2f$ beyond the lens.

Therefore, each measurement made in the Case 1 configuration identifies the specific pinhole in the lower arm through which the photon for that event has passed. On the other hand, each measurement made in the Case 2 configuration intercepts the incoming photons in a broad unfocused blob, so that the lower-arm twin of the upper arm photon could have passed through either pinhole.

In quantum mechanics there is a phenomenon called *superposition*, which involves adding the mathematical descriptions of two or more contributing processes and then calculating the absolute-square of the result to get the probability of particular observations. If there is no information on the specific pinhole through which a photon passed (as in Case 2 above), amplitudes for passage through both pinholes are added to calculate the event probability. The result is a "2-slit interference pattern" structured with sharp peaks and deep valleys. On the other hand, if information is available on the specific pinhole through which a photon passed (as in

Case 1 above), the probability for passage through each pinhole is calculated separately and the probabilities are added. The result is a "1-slit diffraction pattern," a broad bump without much structure.

Thus, by moving the detector in the upper arm of the experiment, the observation in the lower arm changes from an interference pattern to a diffraction pattern. These patterns cannot be distinguished with a single two-photon event, but are easily distinguished with a few dozen such events. Thus, a "signal" can be sent from the upper to the lower arm by moving the upper detector to change the pattern in the lower detector.

We had said above that formal no-signal theorems require that a configuration change at one end of an extended EPR measurement *cannot* alter what is measured in the other end. Does the Dopfer Experiment constitute an experimental falsification of such proofs? Not quite. In the Dopfer Experiment, the pattern in the lower detector was selected by requiring events in which detected photon were in good time-coincidence in both detectors. Therefore, it is possible (barely) that with no coincidences, the same raw pattern would appear in the lower detector, independent of the position of the upper detector, with the coincidences from the upper arm selecting from this raw pattern a diffraction pattern in Case 1 and an interference pattern in Case 2.

However, this scenario seems unlikely. Around 85% of the photons in the lower detector should be in coincidence with photons in the upper detector regardless of position. Therefore, while the coincidence requirement should remove the 15% of noise, it should in itself do little else. In particular, it should not be able to thin out the raw pattern enough to produce the minima of the interference pattern.

Unfortunately, the Dopfer thesis does not discuss what was observed in the lower detector with the coincidence re-

quirement removed. For this reason, a crucial test of quantum phenomena would be to re-create the Dopfer Experiment and observe the role of the coincidence requirement on what is observed in the lower arm detector. Several research groups are considering doing this, but there are no results yet

Okay, now let us suppose, for the sake of argument, that the no-signal theorems are wrong and that EPR signaling is possible. What are the implications?

First, consider that we eliminate the coincidence requirement and modify the upper arm of the Dopfer Experiment by placing the ends of single-mode fiber optic light pipes in the $2f$ plane at the two slit-image positions, so that if the lower photon passes through one of the pinholes, its upper arm twin enters the corresponding light pipe. Suppose that in the corner of the laboratory is a big spool of dual-path fiber optics line, 10 kilometers in length with an index of refraction of 1.5, so that it requires 50 microseconds for light to travel from one end of the coil to the other. At the output ends of the fibers, set to have the same separation as the inputs, we place a new lens of focal length f a distance $2f$ away, so that it images the light emerging from output ends of the fibers at a distance $2f$ beyond the lens. Then, as before, we move our upper detector between the f and $2f$ positions beyond this lens.

According to the rules of quantum entanglement, the position change in the detector of the upper photon should show up as a change in the pattern followed by its entangled twin photon in the lower-arm as it is detected by the lower detector. However, in this case, the change in the pattern of lower arm detection will occur 50 microseconds *before* the upper arm is moved. Therefore, we have a thought experiment that promises to send messages backwards in time, to a time 50 microseconds in the past. In other words, we have a plau-

sible experimental scheme for retro-causal signaling.

Such a result would violate the Principle of Causality. It would also make it possible for an experiment to create a "bilking paradox" or "timelike loop." For example, after the experimenter receives a message from himself some time in the future, he decides *not* to send the message. Or if he does not receive a message, he decides to send one anyway. Or he decides to send a message that is different from the one he just received.

The physics literature on the resolution of such paradoxes is thin, but there have been some speculations. The prevailing view seems to be that Nature would not permit such events. In any real experiment there is some probability of noise responses or equipment failure, and the assertion is that such events are more probable than the occurrence of a timelike loop. In other words, Nature would refuse to be bilked, and any attempt to do so would be met with an equipment failure striking from some improbable but possible direction.

This raises an interesting science-fictional possibility. Suppose you arrange a failure-tolerant experiment such that a timelike loop will definitely be created

unless a certain improbable but desired event should occur. For example, it is required that you win the Powerball Lottery in order to suppress the timelike loop. Would that cause you to win? Can we manipulate probability by intimidating Nature with the possibility of causing timelike loops?

I don't think so, but I also don't understand why a coincidence-free Dopfer experiment could not be performed. We'll see. ■

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Upgrade

Eric James Stone

Through the camera in the waiting room, Harry watched the customer. "Mr. Smith" was standing stiffly, ignoring the chairs and the table full of magazines. Though dressed in jeans and a gray sweatshirt, Smith wore an expensive privacy veil—one that fuzzed the picture even of Harry's high-end Sony equipment.

Harry smiled. Some body upgrades were more acceptable than others—NeverSleep was popular among executives and lawyers, and artificial eyes had become a fashion statement after several Hollywood stars had gotten them. Something like a brain job was an embarrassment: it meant you weren't smart enough with what nature gave you.

Despite the political controversy over upgrades, NHCA insurance would cover most of the cost. But hospitals had to report upgrades to the National Health Care Administration. For privacy, you had to go private. And private took a lot of money.

Harry opened the door between his office and the waiting room. After a moment's hesitation, Smith walked in.

"Have a seat," said Harry, indicating the chair in front of his desk.

Smith sat as Harry closed the door.

"You don't need the privacy veil," said Harry. "This office is secure."

Smith pointed at the silvery mesh over his face. "I'd rather remain any-

mous." The distorting effects of the veil made the voice smoothly androgynous.

With a shrug, Harry said, "I guess I can accommodate you, unless you're looking for brain enhancement. My surgical bots can't work inside that veil."

"I want a DSR."

Surprised, Harry nodded slowly. Outside the military, a digestive system replacement was rarely done for non-medical reasons. Some very busy people liked being able to skip meals and get most of their energy by plugging into the electric grid, allowing the DSR to synthesize glucose by recycling body waste. But for most people, the added body efficiency was not worth the cost.

Harry sighed mentally as his professional ethics took over. "I need to warn you: Back in Washington, some people don't like the idea of human upgrades. If God had meant for man to whatever, etc." He waved his hand in little circles. "If the polls are right, people like that will win next month's election. If they ban future upgrades, that puts me out of business."

Harry leaned forward. "But if, as some of them propose, they ban the *use* of upgrades, you'll either have to leave the country or die."

"You're being melodramatic. It's almost certain the Supreme Court would invalidate a use ban."

Shrugging, Harry said, "Almost cer-

tain? That still leaves some chance they won't."

"You're not going to scare me off."

"Okay. Can you come in next week? I'll have to order the system."

"It may take longer," said Smith. "I want one with the nuclear option."

The TV on Harry's wall showed a map of the United States, divided between blue and red.

"According to the exit polls," said a pundit, "not only will the President be reelected, but her party will gain control of both the House and Senate."

Muting the TV, Harry picked up his phone and dialed the anonymous forwarding number Mr. Smith had given him.

"Yes?" The phone altered the voice so it couldn't be recognized.

"I have the replacement you ordered." Harry was careful not to give details, just in case the voice wasn't Smith.

"Will Saturday work?" asked the voice.

"Yes. Do you want to reconsider, given today's results?"

"No."

"The nuclear generator only replaces the need to plug in to recharge the system," Harry said, going through the NHCA-mandated preinstallation waiver checklist. "You still need to eat occasionally. If you don't replenish the raw materials, your body'll start cannibalizing itself."

"No more than forty-five days without food. I read the specs. Can we get going?"

Harry shook his head. "I have to remind you. Federal regulations, so you can't sue me for malpractice. With regard to water: The DSR recycles what would normally urinate, but you still lose water through perspiration—"

"I'll have access to water. Eating and elimination were the big problems."

"You still have to eliminate," said Harry. "Recycling isn't 100 percent efficient. If you don't add food into the sys-

tem, then only once every sixty days."

"Just check all the boxes, and I'll sign the form," said Smith.

As the surgical bots worked on Smith, Harry leaned back in his chair. Where was Smith going? What sort of environment called for this kind of endurance?

Under water made the most sense. A diving suit with a rebreather/gill system and a distiller to purify water would let him stay down for weeks. Navy SEALs probably did exactly that.

What was Smith up to?

Before Smith left, Harry said, "If you ever need any work done, look me up. I'll probably be opening a clinic in Mexico after Congress bans upgrades."

Smith chuckled; the privacy veil made the sound sterile. "Don't be so sure of that—politicians need upgrades, just like everyone else. Have some faith in human nature."

Harry snorted. "If I had faith in human nature, I wouldn't be upgrading it."

The True Human Act, outlawing most upgrade procedures, passed the House easily. The Senate took up the bill a week later.

Harry cancelled his appointments and watched the debate on C-SPAN2.

Smith was right: politicians used upgrades, too. Even many Senators in favor of the bill showed signs of vocal cord upgrades. Their voices were just too smooth, too resonant.

Senator Velazquez of Texas was no exception. His voice was firm as he took the podium. "My distinguished colleagues, I rise in opposition to this bill."

Something about the stiff way Senator Velazquez stood looked familiar to Harry. He grinned suddenly and said, "Looks like Mr. Smith went to Washington."

Seventeen days into Senator Velazquez's filibuster, the Senators sponsoring the bill withdrew it. ■

Diatomaceous Earth

Jerry Olton

Archeologists often have to guess what things were used for. Paleontology, of course, is an entirely different matter. . . .

Robert wasn't a marine biologist. He was a gardener and a physicist, in that order. Roses were his first love; nanomachines came in a distant second. If asked what he wanted to be remembered for after his death, he would have said "A new cultivar" rather than "A molecular assembler." He was well on the way toward the former, and showing workmanlike progress toward the latter, when disaster struck.

His Edison/Tesla hybrid was showing great promise, with double blooms and a spicy fragrance that hinted rather than shouted its presence in the garden. It seemed hardy enough, even in California's muggy swelter. The change in climate since the turn of the century had killed many a stalwart standby, but the E/T rose, as he had come to think of it, kept struggling on even, when the Floribunda and England and Peace varieties tossed in the towel. He was becoming quite excited over its progress and was already dreaming of the accolades he

would receive when he brought his new creation to the garden show that fall, but those dreams came to an abrupt halt the morning he entered his garden and discovered aphids munching happily on his hybrid hopes.

Aphids! Plant lice. Tiny sapsucking parasites that drained the strength from their hosts like politicians draining money from a researcher's budget. Not a death knell for the plant, but a definite setback, and one that would cost him dearly in time, prestige, and satisfaction.

He should have expected it. When you combined two sets of genes, you not only combined their strengths, but their weaknesses. Obviously, his Edison and his Tesla variants were each slightly susceptible to infestation, and their progeny had unfortunately inherited the gene from both parents. It would undoubtedly be possible to recross the lines and try for a variant that retained the blossom size and fragrance yet showed resistance to aphids as well, but

those variants could be susceptible to heat, or mildew, or a host of other perils. He would be casting his fate on the seas of random chance, hoping for luck to hand him a freebie.

He shouldn't have to rely on luck. Genetic mapping was becoming more of a science every day; it should be possible to learn which genes were responsible for which traits, and select which ones a person wanted in his final product. And if he left out all the "junk" DNA, the unexpressed genes left over from ancestral generations, the new varietal would breed true. There wouldn't be any bad genes to pass along.

The possibilities stretched before him in a direct line to the Nobel, but as Robert knelt before his infested E/T hybrid, he forced himself to focus on the problem at hand. He had aphids on his roses now, today, and he wanted them gone.

There were two basic treatments for aphids. Ladybugs would eat them, or diatomaceous earth would destroy them from within. Robert was a nano-engineer, a designer of machines that manipulated individual atoms; it amused him to think of using the skeletons of microscopic algae to fight the invaders. That's what diatoms were: little single-celled creatures, neither plant nor animal, that filtered silicon dioxide out of seawater and built elaborate, lacy shells out of it. They looked like aquatic pollen grains, spiky and sharp-edged, and when you dusted an aphid with their dried shells, the gritty powder got into the aphid's joints and literally wore them out. It was like throwing sand into an engine; the engine's own movement provided the energy that eventually destroyed it.

Robert had had an aphid problem once before, early in his gardening days. He rummaged around in the back of his equipment shed until he found the can of diatomaceous earth, took it out to the garden and gave all his roses a generous dusting. Then he headed to work at the lab, shifting mental gears during his

commute until the aphids became a distant worry.

The lab held troubles enough to occupy him. Nothing new, but certainly persistent. Robert's team had designed a beautiful assembler, able to stack atoms in just about any shape they wanted, but they were still foundering on the energy problem. Dragging atoms from place to place required energy, and an autonomous assembler couldn't carry a battery pack around with it. It required a chemical power supply, one that could be recharged continuously through its environment. Fed, as it were, like a bacterium in sugar broth.

The more he worked at it, the more convinced he became that the answer lay not in more and more clever mechanical systems, but in biological mimicry. Evolution had already designed the perfect power source for a nanoscale device: the mitochondrion that powered nearly every eukaryotic cell. Keep feeding it glucose, and a mitochondrion would produce enough energy to wave a hundred cilia all day. Why not harness that ability in an artificial cell, rather than design a completely new device?

Robert had discovered several good answers to that question, among them the unfortunate discovery that mitochondria were as much a mystery as the cells they powered. Biologists knew that the instructions for building one were encoded in its own DNA, and they could even unravel that DNA and tell you what genes coded what parts of the mitochondrial structure, but they couldn't tell you how to hook one up to a tiny device that would build, say, a rocket engine one atom at a time.

Today, as he ran yet another dreary computer simulation of another doomed power interface, he found himself thinking back to the diatoms he had sprinkled on his roses. *There* was a nano-assembler. Diatoms seemed to exist for no other reason than to build their amazingly elaborate shells. That and reproduce. The seafloor was covered with

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their skeletal remains, and sediment beds hundreds of feet thick proved they had been doing so for millions of years.

On a whim, Robert did an internet search for information on them, and learned several surprising things, the most interesting being their genome, which was full of junk. Only 20 percent or so of the genes in a given diatom species were active. Furthermore, the unexpressed genes were different for each species tested. If every one of those genes were expressed, diatoms would be as different as apples and walabies. He wondered what all that extra DNA could possibly code for.

He knew just enough about genetics to be dangerous. An afternoon on the internet taught him enough to be really dangerous, because unlike the molecular biologists who sequenced the genome, he had a prototype nano-assembler that could manipulate a DNA molecule the way he could build a trellis for his Climbing Dawns. It didn't have a self-contained power supply, but that didn't matter for this. His test subjects weren't going anywhere.

On the way home from work, he stopped by the beach and collected a bottle of seawater. That would give him plenty of diatoms to experiment on.

He promptly forgot about that when he got home. He rushed through the house to his rose garden and examined his E/T hybrid, hoping to see it completely free of aphids, but there were still dozens of the little green parasites lined up along the stems like moviegoers at a ticket booth. He dusted them again with diatom skeletons, and again in the morning before he went to work. By then the aphids were definitely on the wane, so he dived into his work without any nagging worries, focusing completely on the genetic experiment.

It would take months—maybe even years—to sort through a diatom genome and pick and choose which genes he wanted to activate. On the other hand, it would be the work of days to find the

master “on” switch and throw it for every gene in every diatom in his culture. Then he could feed them and let them reproduce and see what he got, and if something interesting emerged, he could winnow out the genes that coded for that particular trait.

Within a week he had his super-diatoms. He put them in a saltwater aquarium, where they wouldn't face competition from natural diatoms, and in the days that followed he monitored the water for growth.

By the next morning, the water was cloudy with his experiment's progeny. He put a sample under the microscope, but was disappointed to see normal, everyday diatoms. They weren't exactly like the ones he had started with, but they were nothing like what he had expected. Turning on all their DNA had barely changed them.

He let the tank go for a week, but nothing more happened. Someone put a castle in it as a joke, but that was it. Eventually Robert lost interest and dumped the whole works down the drain—after pouring a gallon of bleach in it and letting it soak for a couple of hours first. Nothing known to mankind could live through that, certainly not a diatom, so he didn't give it another thought until several weeks later, when a worker at the sewage treatment plant noticed something odd in a settling pond. It looked like someone had driven a car into the pond, but when a crew hauled it out, they realized it was like no car ever built. It was twice the size of even the most outrageous SUV, and it had stubby little pods where the wheels would normally go. When the sewage treatment people hosed it off and opened it up, they found a fully functional cockpit that powered up when they pushed the big orange button in the middle of it. The car lifted about a foot off the ground and hovered there, and when one of the work crew climbed in, closed the door, and pushed another button, the car shot off into the

sky, taking him on a terrifying but ultimately successful trip into fame and fortune.

It didn't take long to discover what had built the mysterious flying car, nor to learn that the sewage lagoon was full of rapidly growing gadgets of nearly infinite variety. The mutated diatoms—for that was the official explanation for their existence, Robert wisely having decided not to step forward and claim responsibility for them—were apparently building everything in the extensive repertoire of objects that they had originally been programmed to assemble. They weren't restricting themselves to the sewage lagoon, either; that was merely the richest source of raw materials and therefore the first place that they had shown up. Once people began to look, they found them everywhere. The mutated diatoms didn't even require water; they drifted like dust particles with the wind, and wherever they landed they happily began building the accoutrements of a society that had apparently flourished and died on Earth long before humanity was even a concept. Some people thought the dinosaurs must have designed them; others favored a passing alien race that had inadvertently—or deliberately—left behind their technology while picnicking on a beach somewhere.

Either way, the diatom-assembled devices worked, and scientists were suddenly busy taking them back apart and figuring out how. Not that it mattered to the average person; within months everyone who wanted one had a flying car, plus a customizable house and all the technological gadgetry they could wedge into it. Robert quietly went to work and figured out how to turn the assemblers on and off, much to the relief of environmentalists everywhere, who had been afraid that they would convert the entire planet into one vast city.

During it all, Robert continued to refine his Einstein/Tesla hybrid, using the time-honored tradition of winnowing crossbreeds for desirable traits until he found one that had not only the flowers and the aroma that he wanted, but also resistance to aphids. He took it to flower shows, but he was disappointed to learn that his status as a nanotechnologist now overshadowed his status as a botanist.

"Have you seen the new telescope those nanocritters have built?" people would ask him. "I hear they're building a fusion power generator up in Monterey Bay. And the tower rising off the coast of Hawaii is starting to look suspiciously like an interstellar spaceship."

"Yes, yes," Robert would say. "But have you seen my new rose?" ■

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The Technetium Rush

Wil McCarthy

Materials can have many uses,
some of which are talked about
more openly than others. . . .

Bangalore Daily News, 26 July 2011
Byline: Hemant S. Tripathi

Fact: The element technetium is produced in minute quantities by red giant stars so far away that the light they're emitting now will someday shine on your grandchildren's grandchildren. For our purposes here, that's far enough not to matter. Closer to home, the element is sometimes generated by the collision of molybdenum atoms and "heavy hydrogen" from the sun, or by the natural decay of uranium. These are freak occurrences; though, aside from the transuranics (which are about as stable as a life of crime), technetium is the rarest element in the natural universe and forms no known minerals.

Fact: Of the thirty-two possible crystal classes, only one—the gyroidal isometric—had, until recently, never been found in the mineral world. Is it mankind that abhors a vacuum?

Fact: On March 20, 2008, Delhi Univer-

sity-trained geologist Rakesh "Rocky" Solanki, on an apparently routine survey of the alluvial clays north of Bhilwara, Rajasthan, found a deposit of fluorescent orange crystals that he couldn't identify, and so brought back to his Jaipur office for examination. Later named Tc solankite, the crystals were hard, translucent, vaguely lustrous and—considering their gyroidal structure and 20 percent technetium composition—quickly valued at \$5,000 per gram. This is 300 times the price of platinum and twice that of clear uncut diamonds, so we're talking about serious money here. Let's be clear about that.

Since the material had apparently washed down from the nearby Arvalli Mountains sometime in the past thousand years, Solanki's discovery touched off, almost immediately—the greatest land rush since the Canadian diamond wars of the 1990s. But can we really believe Solanki's gambling debts, criminal connections, and curious patterns of

stock and land ownership have nothing to do with his sudden good fortune?

Hey, no one's on trial here; the guy may be as innocent as a bride. Or, this may be one of the most sordid chapters in the oft-opprobrious history of mineral science. Place your bets and let's get moving; this rag doesn't pay me by the hour.

Our story begins with the Canadian Diamond Rush of 1991, when geologists Charles Fipke (a forty-five-year-old with a mere bachelor's degree) and Stewart Blusson (with a pilot's license and twenty years in the bush) braved arctic winters and hungry bears to outwit the De Beers cartel and 258 other mining companies to lay claim to four of the world's richest diamond sites, imprisoned romantically beneath the arctic permafrost. Over a three-year period, fueled by hope and JP4 kerosene, a swarm of helicopters and geological shock troops staked out fifty-three million acres of mineral claims. It was a tale of rogues and spies, claim-jumpers and border skirmishes, camouflage nets, and electronic spoofing. But Fipke was *born* for this world, staying always one step ahead, and ultimately it was his science, more than any skullduggery, that sealed the day. Diamonds are found in volcanic chimneys called "kimberlite pipes," and when the dust and snow had settled he was in possession of all the important ones, leaving only dregs and downwash for his rivals. Unpretentious as any storybook hero, Fipke was worth a billion rupees by the turn of the millennium and yet maintained a modest lifestyle, even continuing his fieldwork. Dirt beneath his fingernails, yes. What a bloke.

Did Rakesh Solanki—then an impressionable teen on a middle-class Bahawalpur cotton farm—hear the tale on NDTV, or read about it somewhere? Or did it simply echo in the public spirit until that afternoon in Bhilwara, when it suddenly gelled?

Jump ahead two years, to 1996. While

America's Internet balloon began its historic inhale, while India's economy struggled out of a thousand-year recession, Rakesh Solanki was a farm boy in a big-city college. In pictures of the day he peers out from behind thick glasses, exuding the funny, cheery confidence of a man well out of his depth and loving it. His grades were fine, his studies went well, but on the side, he was prowling the streets of Delhi, looking for the things young men have always sought. No doubt panning for loose women, our intrepid Rocky instead discovered beer, then hemp, then betting parlors where dice and football could—and often did!—finance the next round of amorous prospecting.

And still his grades were good. Never ruled by his wild side, Solanki ploughed his way through three semesters of foundation courses and was showing particularly well in the earth sciences, which would, he seemed to assume, become an interesting, if modest, career. And then something happened. Like a thunderclap, the petite poetess Abha Abhilasha Vyas crashed into his life. Although we may suspect the irony was lost on our randy young fellow, Ms. Vyas's name can of course be translated as "desire for things that glitter"—an omen further punctuated by the manner of their meeting, in Kamla Nagar's dilapidated Kothari Gamehouse.

It's hard to believe all the witnesses who claim to have been there at the time, but this much seems certain: Clad in a green and gold blouse of questionable opacity, she leaned in front of Rakesh Solanki, so that his view of the TV was replaced with a view of her slight but shapely bosom, and said in Hindi, "Hey, goggles, be a darling and lend me a fifty."

"Buzz off," he answered in English, craning for a view of the game.

To which she replied, "Come on, mate, I've seen you up at the college. I'm a physicist, right? Fascinated with the laws of probability. Help a girl with her homework."

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For Vyas this was presumably no big deal. She was indeed studying physics at Delhi, but she'd grown up in this neighborhood and was known here, and the young man before her did have a certain awkward charm, a bit of money, and an obvious taste for the calendar girls posted round on the walls. Did she really expect the loan? Was she just kidding around? Alas for Solanki, still picking metaphorical cottonseeds out of his sandals, it was love at first (well, second) sight. Here was everything he'd ever dreamed of: a pretty, intelligent woman with a smart mouth and a taste for big-city adventure. The aforementioned bill was handed over with a smirk, and when wagered and lost, was gallantly replaced with another. And thus in five quick minutes was the pattern of their relationship set for all that followed.

Pity him if you like. Pity them both if you must. But listen to all of it before passing judgment; youthful innocence can turn on a heel only, and I mean *only*, if we choose to allow it.

Jump ahead to the turn of the millennium. Stock markets were high, cash was flowing as freely as water, and armies of young programmers in Mumbai and Calcutta were sweeping Y2K bugs out of American and European software. Even Kashmir was working its way toward a ceasefire, lending a dreamy (if fragile) quality to the season.

Having completed two years of graduate school, Solanki's darling Abha Vyas had taken a job at the WRC or Waste Reprocessing Centre of the Kakodar Nuclear Power Station in Jaipur, "breaking big ones into little ones," as they say. That is, bombarding spent uranium fuel rods with the neutron emissions from a thorium reactor, so that massive, long-lived radioactive elements, like plutonium and neptunium, could be broken down into short-lived ones, like radon and actinium. On the side, she was now seeing her science-orientated poems published regularly in *Varnamala* and *Kavya Bharati*,

which paid almost nothing but which stoked her professional reputation and, presumably, her self-esteem. Not that she needed much help in that area.

Rakesh Solanki, meanwhile, who'd been unable to secure anything more than temporary contract employment in his chosen field of geology, was working instead as a forklift operator for the waste disposal firm of Joshi Bhopal, which removed and buried the effluent from, among other places, the Kakodar Nuclear Power Station. It is tempting to speculate that Vyas pulled in a favor somewhere to get him the job, for union jobs were scarce in Jaipur at that time, but there's no evidence of it.

Solanki had of course worked with a variety of machines on his parents' farm, including forklifts, and was by all accounts a capable driver, well liked by his bosses and coworkers, who consulted him sometimes for his earth-science expertise during trenching and filling operations. According to newspaper reports, the team once found a large green nugget of copper oxide in their Malpura dump, which Solanki proclaimed to be "alluvial," or washed down from higher ground. Since the nugget—though interesting—had little monetary value, Solanki was allowed to keep it, and we can suppose the brief local fame brought on by its discovery had some impact on his later thinking. The papers called him a "Joshi Bhopal staff geologist," and he liked the sound of that.

Anyway, while he was hardly a rich man, Solanki's salary was enough to rent not only a small apartment in Jaipur, but also an office in which he slowly built a modest but respectable soil and mineral identification lab, whose services he advertised in the same papers who'd reported his copper find. Business was not exactly booming, but he collected enough odd jobs to build a résumé, and in his spare time, through a combination of personal fieldwork and bargain hunting in the city shops, amassed a rock collection large and photogenic enough to pose in

front of. He'd be ready for the newspapers—or TV, or internet bloggers—the next time they showed up.

So things were going well, and it seems natural enough that Vyas and Solanki, lovers now for two and a half years, should tie the knot and move in together, which is exactly what they did. The ceremony was small, brief, and sparsely reported, and though the newlyweds expressed a desire to travel overseas, in fact the honeymoon was a week in Alibag (near Mumbai), paid for by Solanki's parents and lightly subsidized by Vyas' widowed mother. Affectionate and outgoing in public, the two were in many ways the perfect couple, to the relief of both families and the mild envy of their friends.

But real life hides clouds behind its silver linings, and within that cramped apartment our lovebirds were not quite as happy as they seemed. The affections of a good woman had mellowed Solanki's wandering ways, but the reverse cannot be said for the bride herself, whose weekend gambling was now fueled by a substantially higher income. Once a quirky affectation, the betting now assumed the proportions of a full-blown addiction, for which (at Solanki's insistence) she several times sought counseling. But Vyas, now Abha Solanki, either couldn't or wouldn't mend her ways, and by the end of 2003 she had managed not only to spend most of their combined income, plus her dowry and Rocky's nest egg, but to accumulate (by some accounts) up to a quarter-million rupees in debt, to unsavory characters in whom sympathy was not a notable trait.

"I'm trapped," Rakesh told a friend that winter. "I can't afford the pills to keep her in at night, and without them we come home poorer every week."

To which the friend claims to have replied, "Smart guy like you, Rocky, ought to imagine a way out. Think of a monkey stealing oranges through a fence, eh? He can't pull his hand out, or he thinks he can't, because he won't let go of the orange."

"But I like my orange," said Rocky. "I *adore* my orange."

"Well, then," said the friend. "Only one thing for it: You've got to scale the fence."

"Meaning what?"

"Meaning you're the smart one, and I'm hungry. Let's eat, eh? And then let's drink your troubles away."

But the comment must have struck a chord. *May* have, I meant to say, because what happened next was passing strange and can't be definitely linked to Rakesh Solanki in any way. The paper's solicitor is standing over me as I write this, making sure I don't commit libel. Well, like I say, nobody's calling the man a criminal. Just very, improbably lucky.

Imagine you're an unknown scientist in a backwater town, and your wife—who makes more money than you—is publishing poetry. How do you feed your own ego and reassure yourself you still wear the family trousers? By publishing scientific papers, of course. This isn't easy to do; it takes weeks to write one, and even a minor journal like *South Asia Geology Review* turns away most of what it receives. If you're lucky and the journal editors see promise in your work, it can then take months or even years to get the niggling details just right. For a professor with a gaggle of students at his beck this is perhaps no big deal, but it's enough to drive a lone man to drink and to drive a drinking man to despair. Rooting around in an online database, I could only find three papers by Solanki, with hints that he might have published two more.

But here's where it gets interesting, because while two of these papers are about alluvial minerals in the Malpura clay, the third one is entitled, "Possible Economic Uses for Purified Reactor Waste." Now, it isn't strange for a man to have such ideas, who spends his days burying the poison churned out by his wife's employer. Indeed, Abha—with a knowledge of physics and chemistry complementary to Rocky's own—may have provided some of the inspiration

herself. But it chucks a spanner in the otherwise-functional tale of rags to well-deserved riches because it tips the Solanki hand four years prematurely. It was a minor paper in a minor journal; safe to hope no one would remember it there. Ah, but this is the information age, when nothing but nothing is ever truly forgotten.

Let's roll back a moment here and take a look at the stuff that put Solanki where he is today: Technetium is a white and very shiny metal, similar to platinum, although it's subject to oxidation and will turn gray and powdery if you bake it long enough. It has the eleventh-highest melting point of any element, and its eight neighbors on the periodic chart have all been used to strengthen, harden, and stabilize steel and other alloys, including the tungsten filaments of incandescent light-bulbs, which were still common at the time of Solanki's writing. Four of the neighbors are also colorful additives in glazes and dyes, suggesting a variety of uses for that rarest of birds, technetium, if only people could be gotten interested in it. More importantly, as a so-called beta emitter, it generates a slight but constant electric current, which prevents other metals from corroding. "As a hardener and surface treatment," wrote Rocky, "our friend is simply unmatched."

He even goes so far as to suggest—and this is no speculation on my part!—that a technetium alloy cut with gold and palladium would be perfect for high-value coinage. "Hard, bright, untarnishable and rare, it would be the numismatist's answer to diamond, for such a coin might last nearly forever."

Now, with a radioactive half-life of several million years—meaning a very slow decay, hence little radioactivity—"Tea" (as Solanki playfully called it) is considerably safer than the potions we swallow in radiomedicine, and in fact is only about four times as hazardous as ordinary concrete and granite, which as we all have heard, emit low levels of radon gas. So does a gaslight mantle, as it turns out, although gaslights are even rarer than tung-

sten filaments and may be unfamiliar to readers who've grown up under the cold glare of the white LED. Nevertheless, to place a coin of technetium in one's pocket, immediately adjacent to one's reproductive organs, would take a bit of faith.

Everyone knows, of course, that soon thereafter, technetium coins were in fact minted and sold by a private company called the Palwal Mint and Trust, which can in no way be connected to Rakesh Solanki, Abha Solanki, or the Kakodar Nuclear Power Station. The content and purity of the coins has been verified by any number of outside bodies—matching very closely to the recipe laid down in Solanki's paper—but the actual source of the metal has never been identified. Still, it's a known product of Energy Amplifier Thorium Reactors (or "EATERS," as their proponents call them), of which KNPS is one of only three operating in India, in a total of four worldwide. And about three months before the coins were first unveiled, the Kakodar station was shut down for a day on the excuse of "plumbing adjustments," although an internal memo called it, more specifically, "repairs to correct an unauthorized modification."

The evidence is circumstantial at best; no court would base a conviction on it. The best we can do is dream a little dream; could Abha, short of funds as always, have monkeyed with her precious reactor to produce an excess of technetium for her hubby to dispose? A physicist friend confirms it is possible. Could Rakesh—dressed up in some ungainly homespun radiation suit—have broken open one of his barrels one night, dropped the slag in some centrifugal furnace of his own design, refined out the "tea," and then buried the whole apparatus along with the waste? Again, there's nothing in the laws of physics—or probability—to deny it.

It should be noted, in all fairness and charity, that if such a venture occurred—and I'm not saying it did—the Solankis do not seem to have profited from it. Indeed,

they never moved from their apartment, never bought a car, never took that trip overseas. Not then. But if they owed a lot of money to gangsters, one supposes a lot of strange things could happen around them, with or without their grudging consent.

At any rate, the coins—real enough for any skeptic—were sold in lead-lined jeweler's boxes, and that's where most collectors have kept them. In many western countries and in China and Japan, importation of the coins was prohibited, and in the United States they were classified as a terrorist munition for which five unlucky collectors were handed stiff jail sentences. Don't answer the phone, Yank; let freedom ring and ring. Eventually the Indian government got tired of the diplomatic heat and shut the enterprise down, but before they did, the coins made a lot of money for someone.

Imagine Rakesh Solanki stewing about that.

It's a fact of life in the prison business that prisoners sometimes escape. This should not surprise us; the jailer goes home at night, while his charge remains, staring at walls, the light fixtures, the bars of his cage. Escape is *all* he thinks about. And wasn't Solanki a prisoner of circumstance? Of poverty, of love?

This much is a matter of record: He somehow scraped up the funds to purchase salt-poisoned farmland in the Arvali foothills. A parcel here, a parcel there, slowly adding up to hundreds of dry, worthless hectares. Geologically speaking, though, these peach-colored sites were rich in molybdenum and rhenium and manganese—chemical relatives of technetium. This was *before* he found the gyroidal crystal. Unlike his idol Charles Fipke, Solanki didn't follow a trail of clues back to their source; he bought the source and then, miraculously, discovered the distant clue. Or so he would have us believe.

Perhaps he found his treasure on private lands and then bought the lands

without informing the owners of their worth and *then* filed his mineral claim. Poor scientist that he was, he could perhaps be forgiven for such a fraud; he sold the land for enough money to retire on several times over. And since the original landowner—a cotton farmer like himself—has made out even better by unloading the rest of his farm, there can be little cause for rancor between them. What a bloke.

Unfortunately, there's a snag. "Tea's" longest-lived, least-radioactive isotope is technetium 98, and to the extent it occurs in nature at all, that's the form we'd expect to find. The metal content of Tc solankite, however, includes high levels of Tc 97, which according to my physicist friend, "occurs only as a result of a slow neutron process, which would not occur naturally and certainly not in the uranium-poor Arvalli."

Mmm-hmm.

I'm not saying Solanki whipped that crystal up himself and then hid it in the ground as part of a real estate swindle. Such an accusation would be irresponsible. Still, a funny thing about hoaxes is that they require fantastic skill to pull off. The public may be duped easily enough, but to fool an art expert, fool a geologist, fool the press and the government and assorted thugs and parasites, one has to forge an object of such exacting proportion and composition that to a casual eye—and even to a battery of preliminary tests—it appears genuine. Curse the counterfeiter though we may, we cannot help muttering our admiration through the other side of our mouths. A fine job indeed, the rascal. How did he *do* that?

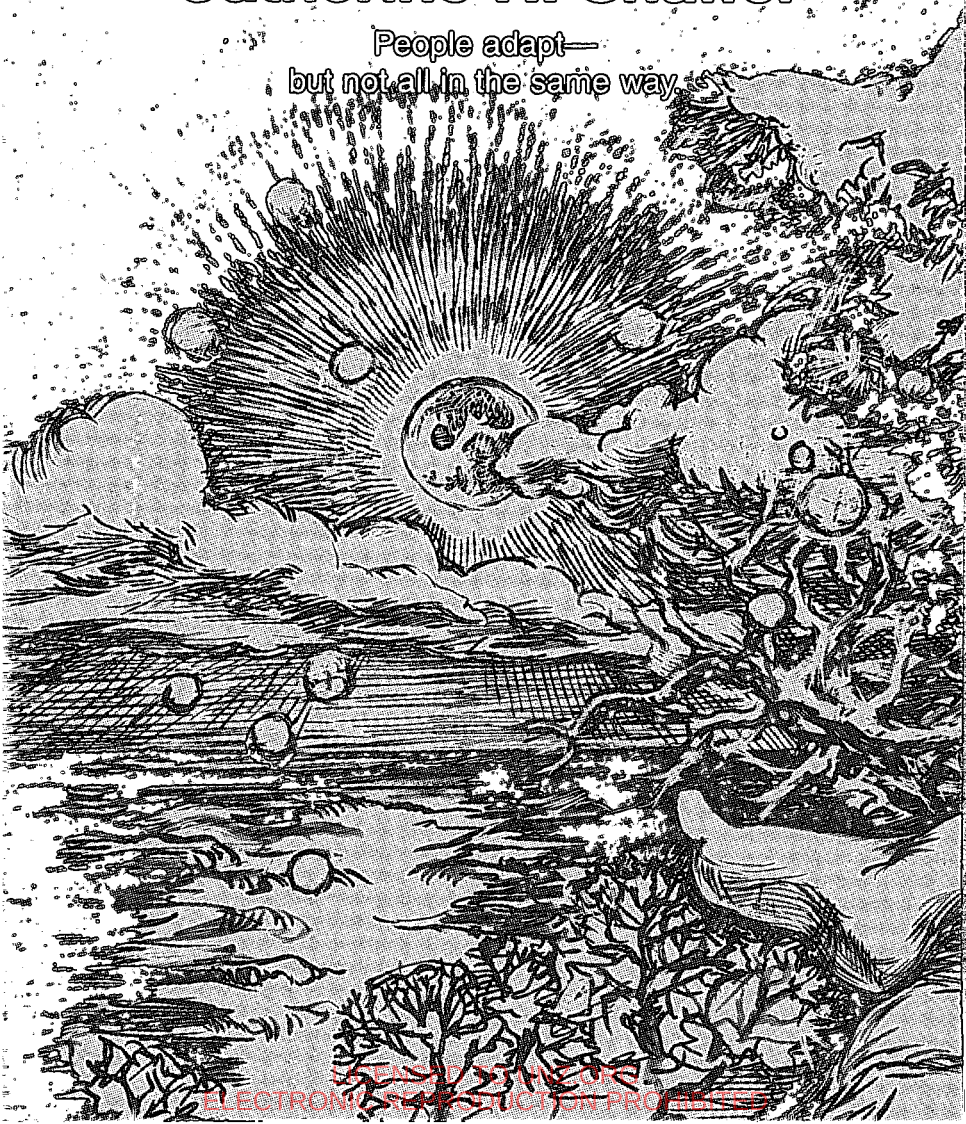
For better or worse, though, the Solankis are unlikely to hang onto their fortune for long. With the land sale finalized and the rupees in the bank, the happy couple have gone at last for the overseas vacation they've dreamed about all these years. Their destination? Las Vegas, Nevada.

Best of luck, mate. ■

LONG WINTER'S NAP

Catherine H. Shaffer

People adapt—
but not all in the same way.



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"E at," said MooninMama, "You have a long winter ahead." LittlestOne turned her head away as MooninMama lifted the spoon of raspberry pie dripping with honey and caribou fat. LittlestOne was sleepy, too sleepy, for what she planned.

"I am already full," said LittlestOne. Her stomach rumbled, giving away her lie.

MooninMama shrugged and set the plate away. It was beginning to get cold in the cave as the crackling fire burned down to embers. Soon it would be time to sleep, time to dream of spring, when they would awaken, shivering, and find that Santy Clawr had visited them.

MooninMama lay next to YediDaddy and pulled LittlestOne down between them, like a baby. All of the others had their own beds.

The hardest part was lying still between MooninMama and YediDaddy without falling asleep. It wasn't like going to sleep at night. There were no blankets to keep them warm, though they had soft beds. More than once, LittlestOne shook herself awake after accidentally nodding off. She wasn't sure she could fight off the long sleep by simple force of will, not with the cold coming down into her bones.

She peeked out from beneath her heavy lids and the cave was dark except for the thin, crackly lines of orange from the dying embers in the fire pit. The taste of sugar rose to her tongue and her hands and feet began to tingle.

MooninMama was still, her breath coming softer and fainter each time. Her bright blue eyes were closed and her cheek as soft as a baby's. Chestnut hair fanned around her shoulders. Her breasts rose and fell softly with her breath. YediDaddy wasn't breathing at all. There was a faint beard of frost on his face, decorating the stubble on his chin. All around lay LittlestOne's brothers and sisters, their children, her aunts and uncles and cousins, her grandpar-

ents, and all the other people of the tribe.

In the summer, when the tribe slept, there were all sorts of sounds in the night. People coughing, snoring, and sometimes laughing, but here there was nothing but a deep silence.

LittlestOne stood up and shook the tingling out. She felt a pang of longing looking at her parents hibernating, but it wasn't enough to keep her with them. She turned to sneak out. She felt dizzy and stumbled several times as she tip-toed across the sleeping bodies of her tribe. Nothing would wake them now but spring.

LittlestOne crawled out of the cave and went to the summer house that YediDaddy had built. She lit a fire and crouched beside it. When she felt completely awake, she went out into the night. It was snowing softly, and there weren't any stars. She had never been so alone.

But she resisted the temptation to go back to the cave with her family. She imagined what they would say when she told them she had met Santy Clawr. They wouldn't think she was such a baby, then!

The days were lonely for LittlestOne. It grew colder and all she wanted to do was go to sleep. Many times she woke herself just on the verge of hibernation, and had to get warm again so she wouldn't miss Santy.

She knew where to find food, even under the snow. MooninMama and YediDaddy kept caches of meat and potatoes underground, where they wouldn't go bad. There were some nuts and berries left on the bushes, and she didn't need to eat much, since she was so small.

Digging through the buried boxes, LittlestOne wondered why there was so much food, with the feast that Santy Clawr would be bringing.

To fight off the loneliness, she sat up on top of the highest hill and looked out over the water. The Hots had called it

Saginaw Bay. The wind blew, raising ridges of white up out of the gray water.

She cracked a walnut with a rock and wondered how long it would be before Santy Clawr came. The snow was as deep as her ankles. She liked to bury her feet in it and wiggle her toes until they popped out like mice. She lay down and stared at the cloudy sky. It was like being rocked in MooninMama's arms. She could still hear the bay nearby, crashing against the shore. It was never this angry in the summer. The wind blew, bearing the bitter scent of snow.

The birds flew away and snow fell. More snow than LittlestOne had ever seen before. Cold wind howled down out of the north, slapping her in the face with the scent of pine needles and deep, gray water. The nights became quieter, broken only by the occasional cry of a wolf. LittlestOne thought she heard the creaking of the glacier, making its slow journey toward their village.

One night, a sound made LittlestOne sit straight up in her bed. It was a wood frog, croaking all by itself in the swamp. LittlestOne hunted for it all the next day, calling softly, "Papa Rana? Papa Rana?"

She found him and took him home inside her cupped hands. "You're waiting for Santy Clawr, too, no?"

In a clay jar by the fire the frog crouched, moving its gullet up and down. LittlestOne appreciated the company, but even more, the frog represented a blessing from the ancestors for her quest. He was the wise and ancient ancestor *Rana sylvatica*, who had taught her people to hibernate, so that they could stay in their homeland when the ice came. Papa Rana had married a human woman, and their children had become LittlestOne's tribe.

If Papa Rana waited for Santy Clawr, staying awake against the approach of winter, so could she.

YediDaddy's summer house got too cold. It was built of sticks and couldn't

keep the wind out. LittlestOne could not sleep there anymore.

To keep warm and not fall too deeply asleep at night, she had to listen to the wisdom of the squirrels. In the fall, squirrels built a nest inside a hollow tree and lined it with leaves. The more leaves they put in, the warmer it was. This was the learning passed down through the tribe from the first ones.

It took a long time to find a hollow tree big enough for LittlestOne. When she crawled inside, she had just enough room to lie down curled up in a ball. She collected lots of leaves and dry grass from beneath the snow and stuffed them inside.

She carried the jar with the wood frog to the hollow tree, but when she got there, he wasn't inside. Now I am truly alone, she thought. The frog had no doubt gone beneath the ground and fallen into hibernation, his insides bathed in blood thick and sweet as honey.

LittlestOne forgot to count the days, and MooninMama was not there to remind her. That was why she didn't know how long she'd been on her own when the Hots arrived.

Snow was pouring down like rain. They flew out of the storm in a shiny metal airplane shaped like a fish and landed right in the middle of the tribal meeting grounds. The bare dirt of the dance ring was covered with snow, so it looked like any clearing in the woods.

At first LittlestOne thought that it was Santy Clawr. But there were no reindeer, and when the door opened on the giant, silver fish, a family came out, not a fat man in a red suit.

There was a Mama and a Daddy in that family and two children near LittlestOne's age. She thought that if they had children, they must be friendly people, so she went out to greet them.

Because they were Hots, they wore a lot of clothes. Great jackets that went up over their heads with fur ruffs and giant shoes that went almost to their knees.

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They hid their hands inside a pair of soft shoes and wrapped cloth around their necks.

The snow fell so heavily that at first the family didn't notice her when she stepped out of the trees. The Mama screamed and the children just stared.

When the screaming stopped, the Daddy coaxed her out of the woods and they took her into the flying fish. Its stomach was a narrow room. Soft benches covered with short, bright red fur lined one wall. There were cupboards on both long walls and windows on the sides that looked out into the snow. A small table sat to one side.

The Mama, mopping tears from her eyes and making little gasping sounds the whole time, dressed her in some lumpy clothes. Perhaps they were planning a religious ceremony. LittlestOne could think of no other reason to wear so much clothing.

The Mama and Daddy went inside a compartment separated from the stomach of the fish by a curtain. The Daddy was communicating with some other Hots by pressing buttons on the inside wall. "About eight years old," she heard him say. "Wandering naked in the woods."

The voices inside the wall sounded like they were talking in a windstorm. "Stay inside the vehicle . . . rescue team will arrive as soon as possible . . . poor visibility."

The Mama whispered to the Daddy, quietly, scolding him for getting them lost in a storm.

There was another Daddy fussing at the stove with a pot of hot water. The children called him Nanny. He had very pale skin and no hair and wore metal bands around his wrists and neck.

The children were excited to meet LittlestOne. "Where are your parents?" the girl asked. She had long, blond hair hanging in two braids down the side of her head. Her name was Shelly.

"They are sleeping," said LittlestOne.

"Under the ground."

Shelly opened her eyes very wide. "You're all by yourself?"

LittlestOne nodded. "I'm waiting for Santa Clawr."

The boy, who was several years younger than his sister, jumped up and down. "Santa Claus! Santa Claus!" he said. His name was Eric.

The blond girl smiled and leaned close to LittlestOne. "I've seen him," she whispered. "We're going to spend Christmas with my grandma in the mountains, and I sent him a letter saying he should bring my presents there on Christmas Eve."

"What's Christmas Eve?" asked LittlestOne.

"She doesn't know what Christmas Eve is?" said the boy.

"It's when Santa flies all over, bringing presents to every boy and girl."

"He couldn't visit all of them in one night!" said LittlestOne. She was disappointed.

"He visits all the children on all the planets in all the galaxies all in one night!" said Eric. "On Christmas Eve!"

The blond girl nodded. "Tonight is Christmas Eve."

"But what if we don't get to Grandma's in time?" said the boy. "Santa won't be able to find us out here by the glaciers."

"I sent a message to Santa, giving him our coordinates. He has good lights on his sleigh," said the Daddy, ducking through the low doorway between the front of the fish and the body. Turning to Nanny, he said, "As soon as the blizzard stops, they'll send a rescue team out to pick up the girl and any other survivors. They gave me instructions to treat her for hypothermia, but when I told them she was uninjured, they became very interested."

LittlestOne sat on her knees with Shelly and Eric on the cushioned bench beneath the window in the side of the fish. Together they peered through the glass out into the night. It was black dark, and they could see nothing but

thick snow swirling madly inches from the glass, like a wall of milk. LittlestOne could have watched it all night.

"We'll have Christmas Eve right here!" said the Mama. "Come, Nanny, let's get everything ready."

Nanny and the Daddy and the Mama reached behind hidden doors inside the flying fish and got out plates piled with food and bright ribbons and colorful gold balls and strings of tiny lights. They laid a splendid meal on the tiny table. There was a platter of steaming meat and vegetables, golden-crustied pies with sweet juices leaking out, and hundreds of candies colored red and white and green. Music began to play, coming from somewhere above LittlestOne's head.

Nanny handed each of the children a curly red and white candy. "Thank you," said LittlestOne.

The Mama laughed suddenly, as if LittlestOne had thanked the cook stove or the music box.

Nanny raised one eyebrow. "You are welcome," he answered.

Nanny set a nativity scene out, and the children gathered around admiring the animals and the wise men. "Where's the baby Jesus?" asked LittlestOne. A silent pause followed, and everyone stared at her blankly.

The best part of the feast was the walnuts. The Daddy set out a bowl of walnuts and some nutcrackers made out of metal and began to crack them. She hardly ate any of the meat and pies because she had so many walnuts. And with the clever nutcrackers, it was easy to get them open.

But even though everyone was having a wonderful time, LittlestOne felt confused. "It's as if Santy Clawr has already been here," she said.

Shelly and Eric laughed. "No, he brings the presents!" said Eric.

LittlestOne looked at him. "Presents?" she asked.

"Yes, you'll see tomorrow."

Every spring when LittlestOne woke

up, there was a feast laid out of venison haunches and tiny sweet cakes and candies made of maple syrup and all the walnuts she could eat. There were bright decorations hung from the trees and dried fruits and dancing and singing. And at the end of the day, WoodchuckMama always gave her a special gift. Last spring, it had been a doll, made of cloth and stuffed with sweet-smelling dried summer grasses, with glass beads for eyes and straw hair. LittlestOne already knew that WoodchuckMama had been working on a beaded dress for her to wear dancing, and that would be her gift for Christmas this year. Could that be what Shelly and Eric expected Santy Clawr to bring them? Perhaps Santy Clawr didn't really visit the Hots after all, and it was just the parents that made a Christmas celebration.

LittlestOne smiled and tried to learn the songs the children were teaching her. But inside she felt as if she might cry, because she was certain that Santy Clawr wasn't coming to the flying fish that night after all.

Suddenly, the door to the rear compartment of the fish burst open, and Nanny came in, dressed in a red suit and a white beard.

Shelly and Eric jumped up and down, cheering. "I told you he would come!" said Eric.

LittlestOne glanced between Nanny and the Mama and Daddy. Daddy was saying, "Come on in, Santa, you're just in time for the celebration!"

Nanny sat down with Shelly on one knee and Eric on the other. The children's eyes glowed, and LittlestOne could tell they really believed that Nanny was Santy Clawr. She wondered if the parents believed it, too. They couldn't possibly, but by now she would believe anything about the crazy Hots.

"What are your Christmas requirements, Shelly?" said Nanny-Santa.

Shelly told him. She listed dozens of items that LittlestOne had never heard

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of. Then Eric took his turn and did the same. When they were done, Littlest-One was offered a turn in Santa's lap. She declined and Santa stepped out into the snow. "I will deliver your gifts between midnight and oh-one-hundred hours," said Santa.

After a while, all the food disappeared and the children began yawning and rubbing their eyes. Nanny reappeared in his regular clothes. Shelly begged to stay up a little later, claiming she wasn't tired. Eric cried and demanded that Nanny leave him alone.

Nanny wrestled LittlestOne into a garment the Hots called pajamas. It covered her body from the neck to the feet. It felt like a steam bath on the inside. "How may I assist you to fall asleep?" he asked her. "I am programmed with one point seven million lullabies in thirteen thousand human languages."

"Nothing, please," said LittlestOne.

The Mama and Daddy slept up above the flying compartment, and the children slept on a bed that unfolded from a bench. LittlestOne was squeezed beside Shelly, with the big kids! Not stuck between a Mama and Daddy, like a tiny baby.

Nanny slept on the floor with no blankets, like a dog.

LittlestOne could feel the heat building in her body, especially her feet, each in its own sack of blanket fabric. She kicked aside the quilt that Nanny had put on top of her and the other children, but it didn't help. At least she wouldn't fall into hibernation inside the Hots' flying fish, but she couldn't get any rest, either, with the warmth flooding her body.

Soon it was silent, except for heavy sighs of the sleeping Hot family. LittlestOne pulled down the metal tab that held her clothing on and slipped out of it. Then she lay on top of the blanket. She was so warm that she couldn't stop fidgeting. She wanted to get up and run and jump, but she didn't want to bother the Hots. Finally, she fell into a fitful sleep.

She woke to hear voices. The three adults were moving silently around the room. They pulled colorful boxes from a compartment high above their heads and whispered to each other.

"Look at her," said the Daddy. "Naked as a jaybird."

"Should I cover her?" asked Nanny.

"No," said the Daddy. "The Washington people think she's some kind of a transgenic. Most likely she's comfortable that way. They've already got a team ready at the National Hospital to study her."

"Transgenic? Isn't that illegal?" said the Mama.

"It wasn't always," said the Daddy.

"There were dozens of isolationist political factions at the time of the diaspora that may have used transgenic technology to survive the Ice Age," said Nanny.

"Poor thing! I'm putting her name on some of Shelly and Eric's gifts," said the Mama. "They'll never know." After a long pause, the Mama spoke again. "Seems cruel to take her away from her home. Do we really have any right?"

"A child wandering alone in the wilderness? It would be cruel to leave her here," the Daddy answered. "It would be different if her parents were still alive to care for her."

LittlestOne watched them through eyes open barely a slit while she pretended to sleep. When they were done piling the presents, they each ate from a plate of cookies, and the Daddy drank a glass of milk. Then they went back to their beds.

LittlestOne lay still, but silent tears rolled down her cheeks, because she knew she would not see Santy Clawr that night, because the presents Eric had talked about were already here, stacked up to the ceiling. More presents than LittlestOne had gotten from Woodchuck-Mama her entire life.

When she was done crying, because no one could cry forever, LittlestOne began to think about her own tribe's

Christmas celebration. When she woke up in the spring, MooninMama and YediDaddy and the other adults were already awake. They must have prepared all the food from the underground caches and laid out the feast while the children still slept, then woke them when it was ready. That would explain why the candies that Santy Clawr brought tasted so much like the ones that SwampunderMama made for the harvest festival. And why MooninMama spent so much time collecting pinecones in the fall. It was a great game, making a surprise for the children, and LittlestOne had never known it.

She smiled in the dark, because she couldn't wait to tell MooninMama and YediDaddy what she had learned. More than anything, this would prove to them that she wasn't a baby anymore. She knew a secret that not even the big kids knew!

Moving slowly and softly, so as not to wake anyone, LittlestOne crept out of the bed where she lay with Shelly and Eric. None of them stirred, except for Nanny, flat on his back on the cold, hard floor. She put one foot over him and froze while he rolled his head back and forth. Then, quick as a snake, his hand

was around her ankle and his yellow eyes were open. "The lavatory is there," he said. "Otherwise, children are required to remain in bed until oh six hundred hours."

LittlestOne met his gaze. His eyes looked human, except for their color. They were moist and ringed with lashes. His skin was faintly scaled. She wondered if there was a Papa Rana for people like him. "Please," she said. "It's too warm in here."

Nanny's grip on her ankle loosened, then let go. He looked at her for a long time, then he put his arm by his side and closed his eyes. Would he be punished? LittlestOne wondered, then she had a sudden image of the Mama scolding the stove or the refrigerator for malfunctioning. She shuddered.

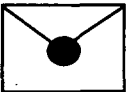
Comforting coolness penetrated the door through its metal parts, soothing LittlestOne's hands when she touched the handle. Whispering one final farewell to the Hot family, she opened it and ran into the night. The blizzard raged on, but LittlestOne found her way to the cave even through the snow, her footsteps disappearing almost as soon as she made them. She lay down between MooninMama and YediDaddy and let hibernation take her, finally. ■

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Rollback

Part III of IV

Robert J. Sawyer

It isn't enough just to communicate.
What matters is *what* is communicated.

THE STORY SO FAR:

*The year is 2048. **Sarah and Donald Halifax**, both eighty-seven, are celebrating their sixtieth wedding anniversary with their children and grandchildren at their Toronto home. Don is melancholy: he knows that this is the last milestone anniversary he and Sarah will be around for; their lives were good and full, but now are drawing to a close.*

Back in 2009, Sarah, then a professor of astronomy at the University of Toronto, had decoded the only radio transmission from another star ever detected by the SETI project—a message from Sigma Draconis, 18.8 light-years away—and she orchestrated Earth's reply to that message.

A phone call comes during the anniversary party. As the astonished Sarah relays to her family: "The aliens from Sigma Draconis have responded to the radio message my team sent all those years ago."

Incredibly, though, the new message is encrypted—scrambled so that it can't be read without a decryption key. It's baffling: the whole point of SETI is to send messages that will be easy to read; the notion that a message would be designed not to be read makes no sense to Sarah.

*The media begin inundating Sarah with phone calls—everyone wants to know what "the Grand Old Woman of SETI" makes of this; Sarah ignores the calls. But she's intrigued when a humanoid robot shows up at her door. Sarah has often said that SETI depends on the kindness of strangers, and one of the most generous of those strangers has been **Cody McGavin**, the billionaire founder of McGavin Robotics. He's sent this robot, carrying a cell phone, because he wants to talk to Sarah. She accepts his call, and he says he's got a proposal for her, and wants to fly her and Don down to Cambridge, Massachusetts, where his company is headquartered.*

Astonished, Sarah agrees, and she and Don meet with McGavin in his office. Sarah, according to McGavin, is the key to communicating with the aliens. Four decades ago, she was the one who figured out what the aliens were asking in their original message, and he's sure that she'll be pivotal in cracking the current one.

As McGavin says, "Planets don't talk to each other. People do. Some specific person on Sigma Draconis II sent the message, and one specific person on this planet—you, Dr. Sarah Halifax—figured out what he'd asked for, and organized our reply. You've got a pen pal, Dr. Halifax. It happens that I, not you, pay the postage, but he's your pen pal."

And so, McGavin says, Sarah needs to be around for subsequent exchanges of messages, even though, because of the speed-of-light time lag, decades will elapse between each one.

Don thinks McGavin is being both ridiculous and cruel, and tells him so: he and Sarah both know that they have only a few years of life left.

Maybe not, says McGavin. He offers to pay for a rollback for Sarah: a new technique that can rejuvenate a person. It costs billions, but it'll return Sarah to being physically in her mid-twenties, giving her many decades of additional life to continue the dialogue with the aliens.

Sarah is startled but intrigued. But she immediately sets out one nonnegotiable condition: McGavin must also pay for a rollback for her husband Don. McGavin initially balks—Don was an audio engineer and producer for CBC Radio before he retired; he's of no use to the SETI effort, and the process is supremely expensive. But the rich man relents, and, after considerable soul-searching, Sarah and Don agree to undergo the procedure.

Tragically, though, the procedure works for Don, but not for Sarah. Rejuvenex, the company that performed the treatment, thinks the failure of Sarah

to become young again may be related to experimental therapies she underwent decades previously for breast cancer—but regardless of the cause, there's nothing they can do. Although it'll take months for Don's rolling back to complete, it's inexorable: he's going to end up being physically in his mid-twenties, while Sarah will remain in her late eighties.

The current message from Sigma Draconis remains unreadable, locked behind an encryption algorithm that the aliens have clearly explained in a header to their message but to which they've failed to provide the decryption key.

In trying to figure out what that key might be—and to keep her mind off the growing age gap between her and her husband—Sarah spends a lot of time contemplating the first message from Sigma Draconis, received way back in 2009. In it, the aliens established that although it's technically correct to write the result of the question "What is eight divided by twelve?" as either $\frac{2}{3}$ or $\frac{4}{6}$, the answer $\frac{2}{3}$ is preferable (because the fraction has been reduced). They also established that whether the number one is or isn't a prime number is a matter of opinion. This mathematical vocabulary allowed them to explore moral issues in the rest of their message.

Sarah vividly recalls the fateful day all those years ago when she finally figured out exactly what the first message was, and what sort of reply the aliens wanted. Her breakthrough had been recognizing that the first message from Sigma Draconis was a survey—a questionnaire on moral and ethical conundrums, laid out with spaces for a thousand sets of replies; the aliens apparently wanted to see a cross-section of human responses.

Sarah had ended up orchestrating the gathering of anonymous replies through a web site, and, at the urging of her son Carl, who had been sixteen

then, she had included her own set of survey responses in the bundle of replies sent to Sigma Draconis.

Now, though, in 2048, Sarah and Don are sadly growing apart. Don has much more physical energy than she does, and that's leading to dissatisfaction in the bedroom. Also, Don's mental acuity has improved since the rollback, causing him, despite his best intentions, to feel irritation at Sarah's difficulty in remembering things.

Don tries to get back his old job—or any job—at CBC Radio, but there's no place for him there. His technical knowledge is decades out of date, and middle-aged employees won't be happy being managed by someone who looks twenty-five. On top of all that, Don's old friends, near the ends of their natural lives, are insanely jealous that he's been given decades more to live. Don is so despondent that he contemplates suicide; after all, he reasons, his life had been almost over before this procedure—ending it now would just be setting things right.

Sarah, believing the decryption key must be something in one of the thousand sets of survey replies sent to Sigma Draconis four decades ago, sends Don down to the University of Toronto to retrieve archived paper copies of those replies. There, Don meets **Lenore Darby**, a twenty-five-year-old SETI grad student working on a master's degree. To Don's delight, she shares his passion for the game Scrabble. They end up having an innocent lunch together, and later in the day, with Sarah's permission, Don joins Lenore and other grad students for chicken wings at a pub.

Lenore is under the impression that Don is Sarah's grandson, rather than her husband, and she's touched when Don vigorously defends Sarah against dismissive comments made by one of the other grad students. Lenore lives in a rough neighborhood a few blocks from the pub, and she asks Don to walk

her home. Once there, she kisses him, and, before Don knows what's happening, they're in bed—the real twenty-five-year-old and the old married man who only appears that way...

Chapter 24

Don fondly remembered the trip he and Sarah had taken to New Zealand in 1992. But Carl had been conceived on that trip, and his birth had put an end to them doing much traveling together for the next couple of decades; Sarah still went all sorts of places to attend conferences, but Don stayed home. He'd been quite sad to miss out on going to Paris with her in 2003 for a symposium with the nifty name "Encoding Altruism: The Art and Science of Interstellar Message Composition." But he *had* gotten to go to Puerto Rico with her in 2010 for the transmission of the official reply to Sigma Draconis. His brother Bill looked after Carl and Emily while they were away.

The city of Arecibo is about seventy-five minutes west of San Juan, and the Arecibo Observatory is ten miles south of the city, although it seemed much farther, Don had thought, as they were driven there on the twisting mountain roads. The landscape was all karst, said the driver: limestone that had been eroded to produce fissures, underground streams, caverns, and sinkholes. The Caverns Rio Camuy, one of the most spectacular cave systems in the world, were southwest of the observatory. And the great radio-telescope dish itself had been built here because nature had kindly provided a thousand-foot-wide sinkhole, perfectly shaped to hold it.

Don had been surprised to see that the dish wasn't solid. Instead, it was made of perforated aluminum slats with gaps between them, all held in place by steel guys. And beneath the dish, in the partial shade, was plenty of lush vegetation, including ferns, wild orchids, and begonias. Around the observatory

grounds, Don was delighted to see mon-
gooses, lizards, fist-sized toads, giant
snails, and dragonflies.

He and Sarah were put up in one of
the VSQs—"Visiting Scientist Quar-
ters"—a wooden cabin on a hill, raised
up above the uneven ground on ten ce-
ment-block pillars. The cabin had a
small porch (excellent, they discovered,
for watching the afternoon thunder-
storms), a tiny kitchen, one little bed-
room, a small bathroom, and a rotary
phone. A boxy air conditioner was in-
stalled just below one of the windows,
all of which were covered on the out-
side by wooden shutters.

Besides being technically a good
choice for sending the message, Areci-
bo was also good symbolically. Seventy-
nine-year-old Frank Drake was on hand
in the control room overlooking the
great dish when Sarah used a USB cable
to connect her Dell notebook comput-
er, containing the master version of the
response, to the transmitter. Drake's
message to M13—until this moment,
the most famous SETI broadcast—had
been sent from here thirty-six years
previously.

As planned, the response contained a
thousand completed surveys, chosen at
random from the 1,206,343 sets of re-
sponses that had been uploaded to the
website Sarah had helped create. Well,
actually, truth be told, 999 of the sets
were randomly chosen; the one thou-
sandth was Sarah's own set, shuffled
into the middle. Not that she'd snuck it
in. Rather, after Don and Carl had put
the notion in her head, she'd broached
the topic of including her own answers
at a meeting, and the PR officer for the
SETI Institute had loved the idea. It
made for a great human-interest angle,
he said.

At the transmission ceremony, com-
memorative CD-ROMs containing
archival copies of the message were dis-
tributed to key researchers, but the ac-
tual responses people had given weren't
being made public. As per the Dragons'

request, the answers were still being
kept secret, so that the participants
wouldn't be influenced by each others'
responses when dealing with follow-up
questions that might come at some
point.

The control room had large floor tiles
set on the diagonal, alternating in a
checkerboard of beige and brown; it
made Don more dizzy to look at them
than it did to look out the angled win-
dow at the great dish, with its 600-ton
triangular instrumentation platform
mounted high above the dish.

Scientists, press, and a few other
spouses were jammed into the control
room. Electric fans were sitting on
pieces of equipment or clamped to
them, but, even though it was still early
in the morning, the heat was oppres-
sive. Don looked on as Sarah sat down at
the central L-shaped desk and brought
up the response on her notebook. He'd
suggested she come up with a memo-
rable phrase—her own "one small step"
speech—but she'd declined; the impor-
tant message was what was going to be
transmitted, not anything she said. And
so, with nothing more than an "All right,
here we go!" Sarah clicked the on-screen
button, and the word "Transmitting" ap-
peared on the notebook's display.

Shouts went up and champagne ap-
peared. Don stood at the periphery, en-
joying seeing Sarah so happy. After a bit,
the beefy, silver-haired representative of
the International Astronomical Union
started tapping on the side of his cham-
pagne glass with a Mont Blanc pen until
he had everyone's attention.

"Sarah," he said, "we've got a little
something for you." He opened one of
the metal lockers mounted to the walls.
Inside was a trophy, with a marble base,
a central column with blue silk inserts,
and, on top, winged Athena stretching
toward the stars. The man bent down,
picked it up, and held it at an angle in
front of him, as though he were apprais-
ing a large bottle of wine. And then, in a
loud, clear voice, he read out the in-

scription on the plaque for all to hear. "For Sarah Halifax," he said, "who figured it out . . ."

Don climbed up the stairs, leaving Lenore's basement apartment. It was past 11:00 P.M., and as Lenore had said, it was a rough neighborhood. But that wasn't why his heart was pounding.

What had he done?

It had all happened so quickly, although he supposed he was naïve to not have realized how Lenore had expected the evening to turn out. But it had been sixty years since he'd really been in his twenties, and, even then, he'd missed the sexual revolution by a decade. The free love of the 1960s had been a little too early for him; like Vietnam and Watergate, they were things he had only vague childhood recollections of, and certainly no firsthand experience.

When, at fifteen, he'd started his own fumbling forays into sexuality—at least, with a partner—people had been afraid of disease. And already one girl in his class at Humberside had gotten pregnant, and that had also had a chilling effect on promiscuity. And so, even though the morality of sex had not been at issue back then—everyone of Don's generation wanted to do it, and few, at least in the middle-class Toronto suburb he grew up in, thought there was anything wrong with doing it before getting married—the act itself was still treated as a big deal, although, given what was to come a decade later, the fear of getting gonorrhea or crabs seemed downright quaint.

But how did the saying go? *Everything old is new again.* AIDS had been conquered, thank God—just about everyone Don's age knew someone who had died from that miserable plague. Most other forms of sexually transmitted disease had been wiped out, or were trivial to cure. And safe, virtually infallible, over-the-counter birth-control drugs for men and women were available here in Canada. That, coupled with a general

loosening up, had led to a second era of sexual openness not seen since the heyday of Haight-Ashbury, Rochdale College, and, yes, the Beatles.

But, as Don continued along the cracked sidewalk, he knew all of that was rationalization. It didn't matter what the morality of young people today was; that wasn't his world. What mattered was what his generation—his and Sarah's—thought. He'd managed sixty years without ever once straying, and now, suddenly—*boom!*

As he rounded off of Euclid onto Bloor, he took out his datacom. "Call Sarah," he said; he needed to hear her voice.

"Hello?"

"Hi, sweetheart," he said. "How—how was the play?"

"It was fine. The guy playing Tevye didn't have a strong enough voice, I thought, but it was still good. How were your wings?"

"Great. Great. I'm just heading to the subway now."

"Oh, okay. Well, I won't wait up."

"No, no. Don't. Just leave my pajamas in the bathroom for me."

"Okay. See you later."

"Right. And . . ."

"Yes."

"I love you, Sarah."

She sounded surprised when she replied. "I love you, too."

"And I'm on my way home."

Chapter 25

"But I still don't get it," Don had said, back in 2009, after Sarah had figured out that the first message from Sigma Draconis was a survey. "I don't see why aliens should care what we think about morals and ethics. I mean, why would they give a damn?"

Sarah and Don were out for another one of their nightly walks. "Because," Sarah said, as they passed the Feins' place, "all races *will* face comparable problems as time goes on, and if the race has any individual psychological

variation—which it will, unless they’ve done as you suggest and become a hive mind—they’ll be debating those issues.”

“Why do you say they must have psychological variation?” he asked.

“Because variation is the *sine qua non* of evolution: without variation, there’s nothing for natural selection to act upon, and without natural selection, there’s nothing to lift a species up out of the slime. Psychology is no different from any other complex trait: it’s going to show variation, everywhere in the universe. And that means there’ll be arguments over fundamental issues.”

“Okay,” he said. There was a cool breeze; he wished he’d worn a long-sleeve shirt. “But the moral issues *they* argue about and the ones *we* argue about aren’t going to be the same.”

Sarah shook her head. “Actually, I bet they *will* be facing the same sorts of questions we are, because advances in science will always lead to the same basic moral quandaries.”

He kicked a pebble. “Like what?”

“Well, consider abortion. It was advancing science that propelled that into being a mainstream issue; the technology to reliably terminate a fetus without killing or maiming the mother is a scientific innovation. We *can* do this now, but *should* we do it?”

“But,” he said, “suppose the Dracons really are dragons—you know, suppose they’re reptiles. I know they probably aren’t; I know the name refers to the constellation they happen to be in from our point of view. But bear with me. If you had a race of intelligent reptiles, then abortion isn’t a technological issue. Smashing the egg in the nest doesn’t physically harm the mother in any way.”

“Yeah, okay, granted,” she said. The pebble Don had kicked was now in her path, and she sent it skittering ahead. “But that’s not the counterpart of abortion; the counterpart of abortion would be destroying the fertilized egg before it’s laid while it’s still inside the mother.”

“But some fish reproduce by having

the female eject unfertilized eggs into the water, and the male eject semen into the water, so that fertilization takes place outside the female’s body.”

“Okay, all right,” said Sarah. “Beings like that wouldn’t have the abortion issue in precisely the same way, but, then again, like I said on *As It Happens*, aquatic beings probably don’t have radio or other technology.”

“But, still, *why* is abortion a moral issue? I mean, it is for people here because we believe at some point a soul enters the body; we just can’t all agree on *what* that point is. But the alien message made no mention of souls.”

“Souls’ is just a shorthand for discussing the question of when life begins, and that *will* be a universal debate—at least among those races who practice SETI.”

“Why?”

“Because SETI is an activity that says life, as opposed to nonlife, is important, that finding life is meaningful. If you didn’t care about the distinction between life and nonlife, all you’d do would be astronomy, not SETI. And where to draw that distinction will always be of interest to people who value life. I mean, most people would agree it’s wrong to kill a dog for no reason, because a dog is clearly alive—but is an embryo alive? *That’s* debatable; every race will have to define when life begins.”

“Well, it either begins at conception or at birth, no?”

Sarah shook her head. “No. Even here on Earth, there are cultures that don’t name kids until they’ve lived forty days, and I’ve even heard it argued that babies aren’t people until they turn three or so—until they begin to form long-term, permanent memories. And even then, there’s still room for moral debate. We know the Dracons reproduce sexually, shuffling their genes while doing so; that was clear from their message. And I rather suspect, by the way, that that sort of reproduction will be common throughout the universe: it provides a

huge kick to evolution; getting a new genetic hand dealt with every generation instead of having to wait around for a cosmic ray to induce a random mutation in a being that otherwise just reproduces exact copies of itself. Remember, life first appeared on this planet four billion years ago, and it spent the first three and half billion of those years basically the same. But when sex was invented half a billion years ago, in the Cambrian explosion—*boom!*—suddenly evolution was proceeding by leaps and bounds. And any race that reproduces sexually might very well still argue about the ethics of destroying a unique combination of genetic material even if they've always held that such a thing wasn't alive until the moment of birth."

Don frowned. "That's like saying it's a moral quandary to worry about destroying snowflakes. Just because something is unique doesn't make it valuable—especially when *everything* in that class of entities is unique."

A chipmunk scampered across the road in front of them. "Besides," continued Don, "speaking of evolution, doesn't the abortion issue ultimately take care of itself, given enough time? I mean, natural selection obviously would favor those people who actually put into practice being pro-life over those who actually choose to personally have abortions, because every fetus you abort is one less set of your genes around. You wait enough generations, and being pro-choice should be bred out of the population."

"Good grief!" Sarah said, shaking her head. "What a revolting thought! But, even so, that's only true if the desire for reproductive choice is merely one of passing convenience, and has nothing to do with whether the kid will make it to reproductive age without too many resources being invested. I mean, look at Barb and Barry—they've essentially devoted their whole lives to raising Freddie." Barb was Sarah's cousin; her

son was severely autistic. "I love Freddie, of course, but in effect, he's replaced potential siblings who would have required a fraction of the investment and would have been far more likely to provide Barb and Barry with grandchildren."

"You know as well as I do, that a vanishingly small number of abortions are because the fetus is defective," said Don. "Hell, we've had abortion for centuries, and only had prenatal screening for decades. Infanticide, that's another thing, but . . ."

"Postpartum depression has its evolutionary roots in the mother recognizing that she has insufficient resources to insure that this particular offspring will survive to reproductive age, and so the mother conserves her parental investment by cutting her losses and failing to bond with the infant. No matter how you slice it, evolution *will* conserve mechanisms that don't always lead to simply having the most offspring. Anyway, setting aside abortion, I still think most races *will* face very similar moral issues as they develop technology that expands their powers. I know the aliens didn't mention God—"

"That's right," Don said smugly.

"—but every race that survives long enough will eventually struggle with the ramifications of getting to *play* God."

It was growing dark; the streetlights flickered on. "'God' is a very loaded term," he said.

"Maybe so, but we don't have a lot of synonyms for the concept: if you define God as the creator of the universe, all races that live long enough eventually become Gods."

"Huh?"

"Think about it. We'll eventually be able to simulate reality so well that it will be indistinguishable from . . . well, from reality, right?"

"One of my favorite authors once said, 'Virtual reality is nothing but air guitar writ large.'"

She snorted, then continued: "And a

sufficiently complex virtual reality could simulate living beings so well that they themselves will actually think they're alive."

"I suppose," he said.

"For sure. Have you seen that game *The Sims* that Carl likes to play? The simulations of reality we can make today are already amazing, and we've only had digital computers for—what?—sixty-five years now. Imagine what sort of reality you could simulate if you had a thousand or a million or a billion times more computing power at hand—which we, or any technological race that lives long enough, eventually will. Again, where do you draw the line between life and nonlife? What rights do those simulated lifeforms have? Those are moral issues all races will have to face."

Another couple, also out for a walk, was coming toward them. Don smiled at them as they passed.

"In fact," she continued, "you could argue there's even some evidence that we ourselves are precisely that: digital creations."

"I'm listening."

"There's a smallest possible length in our universe. The Planck length: 1.6×10^{-35} meters, or about 10^{-20} times the size of a proton; you can't measure a length any smaller than that, supposedly because of quantum effects."

"Okay."

"And," she said, "there must be a smallest unit of time, too, if you think about it: since a particle of light has to be either *here*, at Planck length unit A, or *next to it*, at Planck length unit B, then the time it takes to move from one unit to the next—the time it takes a photon to click over from being in *this* Planck space-unit to *that* Planck space-unit—is the smallest possible bit of time. And that unit, the Planck time, is 10^{-43} seconds."

"The Clock of the Short Now," said Don, pleased with himself.

"Exactly! But think about what that means! We live in a universe made up of

discrete little bits of space that's aging in discrete little chunks of time—a universe that has pixels of distance and duration. We *are* digital at the most fundamental level."

"Quantum physics not as the basic nature of reality, but rather as the—how would you put it?—as a byproduct of the level of resolution of our simulated world." He made an impressed face. "Cool."

"Thanks," she said. "But that means our world, with its pixels of time and space, might be nothing more than some far-advanced civilization's version of *The Sims*—and *that* would mean there's a programmer somewhere."

"I wonder what his email address is," Don said. "I've got some tech-support questions."

"Yeah, well, just remember once you open the seal on the universe, you can't get your money back." They turned a corner. "And speaking of making universes, with particle accelerators we may eventually be able to create daughter universes, budding off from this one. Of course, we won't create a full-blown universe, with stars and galaxies; we'd just create an appropriate singularity, like the one that our universe burst forth from in the big bang, and then the new universe will make itself from that. Physics says it's possible—and I rather suspect it's only a matter of time before someone successfully does it."

"I get it," said Don. "If you take a step back, that means *we* could be living in a universe created by a scientist in some parent universe's particle accelerator."

"Exactly!" said Sarah. "And, look, you know I love following all those debates in the US about the teaching of evolution and intelligent design. Well, I'm an evolutionist—you know that—but I don't agree with the testimony that the scientists on the evolution side keep giving. They keep saying that science cannot admit supernatural causes, by which they mean that any scientific explanation has to, by definition, be limited to

causes intrinsic to this universe."

"What's wrong with that?"

"*Everything* is wrong with it," she said. "That definition of science prevents us from ever concluding that *we* are the product of the work of other scientists, working in a reality above this one. It leaves us with the cockeyed mess of having a scientific worldview that on the one hand freely acknowledges that we will eventually be able to simulate reality perfectly, or maybe even create daughter universes, but on the other hand is constrained against ever allowing that we ourselves might exist in one of those things."

"Maybe science isn't interested in that question simply because it doesn't really answer anything," Don said. "I suspect somebody like Richard Dawkins would say, so what if we are the creation of some other intelligent being? That doesn't answer the question of where that other intelligent being came from."

"But science—and in particular, evolutionary science, which is Dawkins's forte—is largely about tracing lineages, and filling in the stages. If you took a comparable view of evolution, you'd have to say that wondering whether birds really evolved from dinosaurs is a dumb question to bother with, as is wondering whether Lucy was one of our ancestors, since the only truly interesting question is how the original, common ancestor of all life came into being. That's wrong; it's *one* interesting question, but it's hardly the only one worth asking. Whether we live in a created universe is an inherently interesting question, and it's worthy of scientific investigation. And if a creator does exist, or if a race becomes such a creator itself, that immediately raises the moral question of what, if any, accountability or obligation the creations have to that creator—and the flipside, and the part that I think we don't spend nearly enough time debating, which is what if any accountability or obligation our possible creator has to us."

Don took a big step sideways, and looked up at the dark sky. "Hey, God," he said, "be careful with your aim . . ."

"No, seriously," said Sarah. "Technology gives a species the power to prevent life, to create life, to take life on scales small and large; technology ultimately gives the power to be what we would call gods, and, even if our definition of science is blind to it, it raises the possibility that what we are is the result of the work of some other being that would, by virtue of having created us, also deserve that term God. Doesn't mean we have to worship it—but it *does* mean that we, and any other technologically advanced race, will have to deal with ethical questions related both to potentially being Gods ourselves and potentially being the children of Gods."

They jogged across the street, beating an oncoming car. "And so the aliens from Sigma Drac wrote to us asking for our *advice*?" asked Don. He shook his head. "Heaven help them."

Chapter 26

Sarah had said one of the appeals of becoming young again would be having time to read all the great books. Don couldn't quite say that the book he was looking at now—a thriller of the type that would have been sold in drug-store spinner racks when he'd been young the first time—was great, but it was a pleasure to be able to read for hours without getting eye fatigue, and without having to put on his cheaters. Still, eventually, he did get bored with the book, and so he had his datacom scan the TV listings for anything that might interest him, and—

"Hey," he said, looking up from the list the device had provided, "Discovery is showing that old documentary about the first message."

Sarah, seated on the couch, looked over at him; he was leaning back in the chair. "What old documentary?" she said.

"You know," he said, a little impa-

tiently, "that hour-long thing they did when you sent the initial reply to Sigma Draconis."

"Oh," said Sarah. "Yeah."

"Don't you want to watch it?"

"No. I'm sure we've got a recording of it somewhere, anyway."

"Doubtless in some format we can't read anymore. I'm going to put it on."

"I wish you wouldn't," she said.

"Oh, come on!" said Don. "It'll be fun." He looked at the panel above the fireplace. "TV on; Discovery Channel." The picture was razor-sharp and the colors vibrant. Don had forgotten they'd had high-definition TV that long ago; he found lots of older shows unwatchable now, because they'd been videotaped in low-res.

The documentary was already underway. Some aerial footage of the Arecibo radio telescope was being shown, and the voice of a Canadian actor—was it Maury Chaykin?—was doing the narration. Soon, that was replaced with a potted history of SETI: the Drake equation, Project OZMA, the *Pioneer 10* plaque, the *Voyager* records—which, it was duly noted, this being the Canadian version of Discovery Channel, had been designed by Toronto's own Jon Lomberg. Don had forgotten how much of the documentary *wasn't* about Sarah and her work. Maybe he'd go into the kitchen to get a drink, and—

And suddenly, there she was, on the screen, and—

And he looked over at his wife, seated on the couch, then back at the monitor, then shifted his gaze between the two once more. She was steadfastly staring at the fireplace, it seemed, not the magphotonic panel above it, and she was red in the face, as if embarrassed, because—

Because she looked so much younger, so much less frail, on the monitor. After all, this had been recorded thirty-eight years ago, back when she was forty-nine. It was a sort of rollback, a regressing to a younger state; oh, to be sure, not nearly as far back as he had gone,

but still a bitter taste of what might have been.

"I'm sorry, sweetheart," he said, softly, and then, more loudly, into the air: "TV off."

She looked over at him, her face expressionless. "I'm sorry, too," she said.

As the day wore on, Sarah went up to Carl's old room, to work through the giant stack of papers Don had brought her from the university.

Don, meanwhile, went down to the basement. He and Sarah had almost given up on using the rec room as they'd gotten older. The stairs down to it were particularly steep, and there was a banister only on the wall side. But he now had no trouble going down there, and, on these hot summer days, it was the coolest place in the house.

Not to mention the most private.

He sat on the old couch there, and looked about, a fluttering in his stomach. History had been made here. Right over there, Sarah had figured out the meat of the original message. And history might be made in this house again, if she could decrypt the Dracons' latest transmission. Perhaps someday there'd be a plaque on their front lawn.

Don was holding his datacom tightly in his hand, and its plastic shell was now moist with his perspiration. Although he'd fantasized about seeing Lenore again, he knew that could never happen. But she'd made him promise to call, and he couldn't just ignore her, couldn't leave her hanging. That would be wrong, mean, petty. No, he had to call her up and say good-bye properly. He'd tell her the truth, tell her there was someone else.

He took a deep breath, let it out slowly, opened the datacom, snapped it immediately shut, and then, at last, opened it once more, gingerly, as though lifting the lid on a coffin.

And he spoke to the little device, telling it who he wanted to contact, and—

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Rings. The tolling of a bell. And then—

A squeaky voice. "Hello?"

"Hi, Lenore," he said, his heart jackhammering. "It's Don."

Silence.

"You know, Don Halifax."

"Hello," Lenore said again, this time her tone icy cold.

"Look, I'm sorry I haven't called you, but . . ."

"It *has* been three days."

"Yes, I know, I know, and I'm sorry. I really did mean to call. I didn't want you to think I was one of those guys who . . . well, you know, one of those guys who doesn't call."

"Could have fooled me," she said.

He cringed. "I'm sorry. You deserve way better—"

"Yes, I do."

"I know. But, look, I—"

"Didn't you have a good time?"

"I had a great time," he said. And he had—just about the only time he'd been happy for weeks now. Not just the sex, but just being with someone who could keep up with him, and—

Lenore sounded relieved. "Good. 'Cause, I did too. You . . . you're really something."

"Um, thanks. So are you. But, um . . ."

"Look," she said, her tone conveying that she was making a special dispensation, "I'm busy at the food bank tomorrow. But I'm free on Sunday. Maybe we could get together then?"

No, thought Don.

"What did you have in mind?" he said, astonished to hear himself speak the words.

"The forecast says it's going to be gorgeous. Why don't we go down to Centre Island?"

I cannot do this, he thought. I will not do this.

"Don?" said Lenore, into what had become an uncomfortable silence.

He closed his eyes. "Sure," he said. "Sure, why not?"

Don had arrived at the ferry docks at the foot of Bay Street about ten minutes early, and he kept scanning the crowds, looking for—

Ah, there she was: the rare and radiant maiden whom the angels named Lenore. She came running over to him, in white short-shorts and a loose-fitting white top, clutching a giant sun hat. She stretched up and kissed him quickly on the mouth, and then pulled back, smiling, and—

And he was stunned. In his mind, he'd aged her forward: he'd been picturing her as being in her mid-thirties, which seemed a more appropriate age for someone he might want to talk to, but here she was, freckled and fresh-faced, looking ten years younger than that.

They boarded the *Max Haines*, a white, double-decker ferry, and took the kilometer-and-a-half journey to Centre Island, with its boardwalks, beaches, amusement park, and gardens.

Lenore had wanted to come down here, she said, because she missed the water. But the result was not proving entirely satisfactory: gulls eating garbage were no substitute for Vancouver's great blue herons, and, besides, there was no salt tang to the air. Once they'd docked, they jogged for about half an hour. Don found that exhilarating, and he loved to feel his hair—yes, hair!—whipping in the breeze.

After that, they just strolled along a paved walkway, gingerly trying to avoid all the goose droppings. Off to their right was the bay, and across it was Toronto itself, with the skyline that Don had watched grow and spread over the better part of a century. It was still dominated by the CN Tower, once, but certainly no longer, the tallest freestanding structure in the world; as a teenager, he had gone downtown with his friend Ivan to watch a Sikorsky Skycrane assemble its huge components. Blockish skyscrapers, like the elements of a bar chart, trailed off left and right from the Tower. He recalled when Toronto's

downtown had been a tiny cluster of tall buildings, but now it went on and on along the lakeshore, west toward Mississauga, and east until the Scarborough Bluffs forced it to stop.

More than just the skyline had changed during Don's lifetime—and yet some things *hadn't* changed nearly as much as he'd expected. He remembered seeing *2001: A Space Odyssey* with his dad when it had come out, back in 1968. The nice thing about being born in a year that ends in a zero was that it made math simple. Even as a kid, he knew he'd be forty-one in 2001, and his father, sitting next to him at Toronto's Glendale Theatre, had been forty-three then, meaning Don would be younger than him when the wonders that film portrayed were supposed to come to pass: Pan Am space planes, giant wheel-shaped space stations with Howard Johnson hotels, cities on the moon, humans traveling out to Jupiter, cryogenic suspended animation, and—*Open the pod-bay doors, Hal*—true artificial intelligence.

But by the time the actual 2001 had rolled around, none of those things were realities. So perhaps Don shouldn't have been too surprised that the extravagant wonders predicted in the science fiction of the first decade of the new millennium likewise hadn't materialized. The technological singularity had never happened; extreme body modification, either through genetic engineering or with artificial parts, never became popular; the nanotech assembler that could turn anything into anything else was still the stuff of dreams.

Don looked out over the water, back at the city he'd been born in. Nestled at the foot of the CN Tower was the stadium where the Blue Jays played. He pointed at it. "See? The roof's open on SkyDome."

Lenore looked at him as though he were speaking a foreign language, and—

Oh, shit. *He* still referred to it as SkyDome; so did lots of people his age. But

that hadn't been its name for over forty years. Christ, the gap between them was everywhere, in everything. "The Rogers Centre, I mean. The, um, the roof is open." It was such a trivial observation, he was sorry now he'd made it.

"Well, it *is* a lovely day," said Lenore. It buoyed him that she made no further comment on what he'd said.

They were holding hands as they walked, skateboarders, hoverpadders, rollerbladers, and joggers passing them in both directions. She was wearing her big, floppy hat; with her pale skin, she doubtless burned easily. For his part, he was enjoying being out in the sun *without* having to wear a hat. After four decades of baldness, it was wonderful to have his own built-in protection.

They'd talked about this and that: a lively, animated conversation, so unlike—what had one of his friends called it?—the companionable silence of old married people who had, decades ago, run out of points of view to share or jokes to tell or issues to explore.

"Do you play tennis?" Lenore asked, as they passed a couple of people carrying racquets.

"I haven't since . . ." *Since before you were born.*

"We should play sometime. I can get you a guest pass to Hart House."

"That'd be great," Don said. And he meant it. He'd been sedentary the first time he'd been this age; now, he was loving the sheer physicality of being alive. "You realize I'm going to beat your pants, off, though. I mean, I'm medically enhanced."

She grinned. "Oh, yeah?"

"Sure. Just call me Bjorn Borg."

She looked at him, totally baffled, and his heart fell a bit. Sarah would have gotten the joke.

"Um," he said, painfully aware of Johnny Carson's dictum that it isn't funny if you have to explain it, "Bjorn Borg was a famous tennis player; won Wimbledon five times in a row. And the Borg; well, they're this alien race on an old TV

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show called *Star Trek*. The Borg augmented their bodies with technology, so, um . . ."

"You are a supremely silly man," Lenore said, smiling warmly at him.

He stopped dead in his tracks, and looked—*really* looked, for the first time—at Lenore.

She was a grad student studying SETI.

She liked to eat in restaurants, to talk about philosophy and politics.

She was confident and funny and a joy to be with.

And now she was even *talking* like—

But he'd missed putting it together until just now. She reminded him of—

Of course. Of course.

She reminded him of Sarah as *she'd* been back in her twenties, back when Don had fallen in love with her.

Oh, true, they looked nothing alike physically, and perhaps that's why he'd failed to notice all the other similarities when they'd been together before. Lenore was shorter than Sarah, or, at least, shorter than Sarah had been in her prime. And Sarah had originally had brown hair, and still had blue-gray eyes, while Lenore was redheaded, freckled, and green-eyed.

But in spirit, in attitude, in the joy they took in life, they were kindred spirits.

Coming toward them was a young couple: an Asian woman and a white man, the man pushing a stroller. Don was wearing sunglasses—as was Lenore—so he felt no compunction about looking at the beautiful young woman, with long black hair, wearing pink shorts and a red tank top.

"Cute kid," said Lenore.

"Um, yeah," said Don. He hadn't even noticed.

"Do you—do you like kids?" Lenore asked, a tentative note in her voice.

"Sure. Of course."

"Me, too," she said.

There was a park bench on the grass a short distance from the walkway, facing back across the water toward the city. Don pointed at it with his chin, and they

went over and sat. He put his arm around her shoulders, and they stared out at the water, watching a ferry coming toward them.

"Do you want to have kids of your own?" he asked.

"Oh, yeah. Definitely."

"How soon?"

She leaned her head against his shoulder. Her hair was blowing a bit in the breeze, occasionally gently slapping his cheek. "Oh, I don't know. By the time I'm thirty, I suppose. I know that's a long time from now, but . . ."

She trailed off, but he found himself shaking his head. Five years would go by like *that*; it seemed only yesterday he'd been in his seventies. Hell, it hardly seemed that long ago that he'd been in his sixties. The years just fly by, and—

And he wondered if that would still be true. He'd certainly experienced the phenomenon of time seeming to pass more quickly as he'd gotten older, and he'd read the pop-psychology explanation for it: that, when you're a kid of ten, each year is a whopping ten percent of your life to date, and so seems ponderously long, but by the time you're fifty, each year is just two percent of your life, and so passes in the wink of an eye. He wondered what would happen to his time sense now that he was young again. He'd be one of the first people ever to get to test the validity of the standard explanation.

Lenore said nothing more; she just looked out at the lake. Still, it was ironic, he realized. She was thinking farther into the future than he was. But he'd thought he was *done* with the future, and, although he knew that poem, too, he hadn't planned on raging against the dying of the light . . .

In five years, Lenore would likely have a Ph.D., and be well on her way in her career.

And in five years, Sarah would probably be . . .

He hated to think about it, but it was all but inevitable. By 2053, Sarah would-

almost certainly be gone, and he'd—

He'd be alone. Unless—

Unless he ...

Unless he found somebody else.

But he'd seen at the grad students' wing night just how vapid most twenty-five-year-olds were. People who shared his apparent physical age would never appeal to him intellectually, emotionally. Lenore, somehow, was different, and—

And it was way too soon to go further with this conversation, but the reality was clear: his future with Lenore, or, he imagined, with just about any woman who was as young as he looked, would depend on his being willing to be a father again.

But, God, to have more kids! Could he face late-night feedings, and changing diapers, and being a disciplinarian?

And yet ...

And yet perhaps people would forgive him his transgressions if someday he did start a second family. He knew that no matter how *logical* it might be for him to want the company of someone so much younger than Sarah, in the eyes of his friends and family that would be seen as tawdry, thinking with his dick instead of his brain. But if they thought his desire was to be a father again, well, then maybe that wasn't quite so bad.

In this age of open sexuality, online and off, it was probably no longer true, but in Don's day, many men he knew had had a favorite *Playboy* Playmate, and his had been Vicki Smith, or, at least, that had been the name he'd first encountered the five-foot-eleven, Rubenesque Texan under, when she was Miss May 1992. But by the time she'd been named Playmate of the Year in 1993, she'd changed her stage name to Anna Nicole Smith. And she became even more famous when, at twenty-six, she married a billionaire who was almost ninety.

That's the comparison people of his generation would make, he knew. Except that he wasn't a billionaire, al-

though he'd gotten what that crazed old coot doubtless would have traded his entire fortune for. And it was he, not the woman, who was fake. Anna Nicole Smith had had an A-cup before breast implants pushed her three letters down the alphabet. But Lenore was natural—well, as natural as anyone these days. It was Don who'd had himself remade, although somehow, at least to him, gene therapy and the lengthening of telomeres seemed less creepy than having your chest carved open and bags of silicone shoved inside.

Still, an eighty-seven-year-old man and a twenty-five-year-old woman! The things people would say! But if he eventually had more kids, became a dad to little ones again, well, then, that was good and normal and right, and maybe everyone would understand, everyone would forgive.

Of course, that was no reason to become a father, but, hell, he hadn't given it *any* thought the first time; it hadn't taken any justification. It had just seemed the most natural thing in the world when he and Sarah had gotten married.

Three ducks landed on the lake, small wakes appearing behind them. Lenore snuggled closer to Don. "It's such a beautiful day," she said.

He nodded, and stroked her shoulder gently, wondering what the future might hold.

Chapter 27

Don had had a truly wonderful time both down at the Island and afterward, back at Lenore's. But she had a lot of reading to do for a seminar tomorrow, so extricating himself at the end of the day had not been an issue. Sarah, meanwhile, had said she was going to stay in all day—she was still sorting through the mountain of paper records about the first message—and as Don headed toward the subway, he was startled that the answering machine picked up when he tried to call his house. Of course,

Sarah's hearing wasn't what it used to be; she might simply have not heard the phone ringing, or she might be out, or—

"Where is Sarah's datacom?" he said to his own unit.

"At home," the device replied, after connecting with its twin. "On her night stand."

Don felt himself frowning; she wouldn't have gone out without it, and he'd tried now calling both her datacom and their land-line household phone. Something was wrong; he just knew it.

He started jogging toward Bathurst subway station; the parts between here and that station, and between his home station of North York Centre and his front door, were the only segments of the journey he could speed up. The rest would happen at what he was sure would seem the snail's pace of the Toronto Transit Commission's trains—taking a taxi all the way up to North York would cost a fortune and would be no faster.

As luck would have it, he got through the turnstile and down the escalator just in time to see the doors close on the eastbound train, and he had to wait an interminable time—this being Sunday evening—for the next one to pull into the station.

His datacom worked just fine down in tunnels, but each time he called, his household phone rang and rang until his own voice—his own *previous* voice, the thin, weary version of it that sounded so different from the way he currently did—came on, saying, "Hello. Neither Sarah nor I can come to the phone right now..."

Don sat, looking down at the gray, dirty floor, holding his face up with his hands.

Finally, after an eternity, the subway arrived at North York Centre, and he bounded out of the car. He ran up the escalator, through a turnstile, and exited onto Park Home Avenue, which was dark and deserted. He jogged the three

blocks to his house, trying once more to call along the way, but to no avail. At last, he opened his front door, and—

She was lying face down on the scuffed hardwood floor in front of the mirrored closet. "Sarah!"

Her limbs were splayed, and the lightweight summer dress she was wearing had billowed about her like a shroud. It seemed clear that she'd taken a tumble coming down the stairs to the entryway. "Sarah, are you all right?"

She stirred, lifting her head a little.

"No," said Don. "No, no. Don't move!"

"My leg," she said softly. "My God, you should have heard the *snap*..."

He'd learned some first aid years ago. "This one?" he said, touching her right leg.

"No. The other one."

He shifted the dress so that he could see her leg, and the bruising and swelling were obvious. He touched it gingerly, and he saw Sarah wince. There was no phone in the entryway; Sarah would have had to have pulled herself up the six stairs to the living room to call him; she had neither the sense of balance nor the strength in her other leg to hop. He got out his datacom, and said to it, "Nine-one-one," a term now used as a name in this post-phone-number age.

"Fire, police, or ambulance?" asked the operator.

"Ambulance," Don said. "Please hurry!"

"You're calling from a mobile device," the operator said, "but we have the GPS coordinates. You're at—" and she read the address to him. "Correct?"

"Yes, yes."

"What's happened?"

He gulped for air. "My wife—she's eighty-seven, and she's fallen down some stairs."

"I've dispatched the ambulance," said the operator. "The datacom you're calling from is registered to Donald R. Halifax; is that you?"

"Yes."

"Is your wife conscious, Mr. Halifax?"

"Yes. But her leg is broken. I'm sure of it."

"Don't move her, then. Don't try to move her."

"I won't. I haven't."

"Is the door to your house unlocked?"

He looked up. The door was still wide open. "Yes."

"All right. Don't leave her."

Don took his wife's hand. "No, no, I won't." God, why hadn't he been here? He looked into her pale blue eyes, which were bloodshot and half-closed. "I won't leave her. I swear I won't ever leave her."

He finished with the operator, and put the datacom down on the floor. "I'm sorry," he said to Sarah. "I'm so sorry."

"It's all right," she said, weakly. "I knew you'd be home soon, although..."

She left the thought unspoken, but doubtless she'd been thinking he should have been home earlier than this.

"I'm sorry," said Don again, his gut clenching. "I'm sorry, I'm sorry, I am so sorry..."

"It's okay," insisted Sarah, and she managed a small smile. "No permanent damage done, I'm sure. After all, this is the age of miracle and wonder." A song lyric, from their youth. Don recognized it, but shook his head slightly, lost. She gestured with her head at him, and, after a moment, he got it: she was referring to his new, younger form. Now *she* was holding *his* hand, comforting him. "It'll be all right," she said. "Everything will be fine."

He couldn't meet her eyes as they waited and waited until, at last, the ambulance's siren drowned out the thoughts that were torturing him, and everything was bathed in strobing red through the open front door.

Chapter 28

Fortunately, it was a clean, simple fracture. Orthopedics had come a long way since Don had broken his own leg in 1977, during a high-school football

game. The pieces of Sarah's femur were aligned, some of the excess fluid was drained off, Sarah was given the calcium infusion into her legs that she would have received anyway had the rejuvenation process worked on her, and a small external support was erected around her leg—these days, only dinosaur bones were wrapped in plaster. The doctor said she'd be fine in two months, and, with the support, which had its own little motors, she wouldn't even need crutches while she healed, although a cane was advisable.

Fortunately, too, their provincial health plan covered all this. Most of the crises in Canadian health care had passed. Yes, there'd been a period when biotechnology had been young, during which costs had spiraled out of control, but all technologies come down in price with time, even medical ones. Procedures that cost hundreds of thousands of dollars in Don's youth now cost a tiny fraction of that. Even sophisticated pharmaceuticals were so inexpensive to develop and produce that governments could give them away in the Third World. Why, someday, even the magic of rejuvenation would be available to all those who wanted it.

Once they got home from the hospital, Don helped Sarah get ready for bed. Within minutes of lying down, she was asleep, helped into the arms of Morpheus, no doubt, by the painkillers the doctor had prescribed.

Don, however, couldn't sleep. He just lay on his back, staring up in the dark at the ceiling, an occasional band of light caused by a passing car sweeping across it.

He loved Sarah. He'd loved her for almost his entire life. And he never, ever wanted to hurt her. But when she'd needed him, he wasn't there for her.

He heard a siren in the distance; someone else with their own crisis, just like the one they'd faced today.

No. No, *they* hadn't faced it. *Sarah* had faced it—face down, on the hard

ANALOG

wooden floor, waiting hour after hour for him to return while he fucked a woman less than half—Christ, less than a third!—his age.

He rolled onto his side, his back to the sleeping Sarah, his body tucked into a fetal position, hugging himself. His eyes focussed on the softly glowing blue numerals of a digital clock on his nightstand, and he watched the minutes crawl by.

For the first time in years, Sarah was sitting in the La-Z-Boy with it reclined. It was, she said, easier and more comfortable to have her injured leg stretched out.

Despite hardly sleeping at all the previous night, Don was unable to rest; he kept pacing. She had once quipped that they'd both fallen in love with this house at first sight—her because of the fireplace, him because of the long, narrow living room that just cried out for someone to march back and forth in it.

"What are you going to do today?" Sarah asked him. The foot-high digits on the wall monitor showed 9:22 A.M. The windows on either side of the fireplace had polarized, reducing the August sunshine to a tolerable level.

He halted in his pacing for a moment and looked at his wife. "Do?" he said. "I'm going to stay here, look after you."

But she shook her head. "You can't spend the rest of your life—the rest of *my* life—as a shut-in. I see how much energy you've got. Look at yourself! You can't sit still."

"Yes, but—"

"But what? I'll be fine."

"You weren't fine yesterday," he said, and he resumed walking. "And . . ."

"And what?" said Sarah.

He said nothing, his back to her. But people who'd been married so long could finish each other's sentences, even when one of them didn't want the other to do so. "And it's only going to get worse, right?" said Sarah.

Don tilted his head, conceding that

she'd guessed correctly. He looked out the brown-tinged window. They'd bought this place in 1988, just after getting married, his parents, and Sarah's, too, helping with the down payment. Back then, Betty Ann Drive had had a few skinny trees here and there, plus one or two large blue spruces. Now, those skinny trees, planted for free by the City of North York, a municipality that didn't even exist anymore, had grown to be tall, luxurious maples and oaks.

He continued walking, now approaching her. "You need me here," he said, "to take care of you."

She looked down at her leg encased in the armature. "I need *someone*, yes. Maybe Percy—"

"Percy starts grade eight in two weeks," he said. "He'll be too busy. And Carl and Emily both work during the day. And we can't afford to hire a home-care worker."

"We could if . . ." she began, and he mentally finished *that* sentence: *if we sold the house*.

He looked out one of the windows again. Yes, this house, small though it was, was bigger than they needed, and had been since Emily had moved out more than twenty years ago. Maybe they *should* sell it. As was now painfully obvious, Sarah was having real trouble with the stairs. Moving to an apartment would free up money *and* deal with that problem.

He'd reached the far end of the room and turned around, facing his wife again, and he saw her expression brighten. "You know what we need?" she said. "A Mozo."

"Mozo?" He said it the way she had, with two long-O sounds.

She nodded. "You know what that is?"

"I know it's worth fifteen points."

Sarah frowned. "It means 'male servant,'" she said. "It's from the Spanish. But it's also the brand name for a line of robots designed to help the elderly."

Don narrowed his eyes. "They make such things?"

"See what I mean?" said Sarah. "You have *got* to get out more. Yes, they make such things, if by 'they,' you mean McGavin Robotics."

He stopped pacing. "Even a low-end bot costs a fortune."

"Sure. But Cody thinks I've got some special insight into decrypting the response from Sigma Drac. I'll tell him I need a Mozo. It wouldn't be a lie. I could easily get more done with someone to serve as a research assistant, get me coffee, and so on. And it would mean I'd never be alone. You could go out without worrying about me."

He thought about complaining that the last time they'd taken charity from McGavin, it hadn't worked out so well. But Sarah was right. He'd go nuts if he had to stay home all the time, and, well, a housebot would make a lot of things easier, wouldn't it?

Chapter 29

It was as though Ikea sold mechanical men. The Mozo arrived disassembled in a cubic crate that measured about a meter on a side. Don found it disconcerting seeing the head in a plastic bag, and it took him a good five minutes to figure out how to connect the legs (which were stored folded in half at the knee). But, at last, it was done. The robot was sky blue trimmed with silver; its body was covered with a soft material like that used to make wet suits. It had a round head about the size of a basketball, with two glassy eyes. And it had a mouth, of sorts. He had seen similar things on some other robots he'd run into: a horizontal black line beneath the eyes that could animate to match speech patterns. Although the market for robots that looked more or less human was small, people did like robots to have some facial expression.

Don couldn't help comparing their new robot to the fictional bots of his youth. He decided that, except for the

mouth, it looked most like one of those from the old Gold Key comic *Magnus, Robot Fighter*. And, he had to admit, it *was* way cool having one, and not just because it let him put a check mark beside another of those twenty items on his old high-school list of things to do.

He looked at the Mozo, another modern miracle they couldn't afford. "Well," he said, hands on his hips, "what do you think?"

"It looks nice enough," said Sarah. "Shall we turn it on?"

Don was amused to see that the switch was a recessed button in the middle of the robot's torso; their Mozo had an innie. He pressed the switch, and—

"Hello," said a plain male voice. The mouth outline moved in a cartoonish approximation of the shapes human lips would have made. "Do you speak English? *Hola. ¿Habla Español? Bonjour. Parlez-vous Français? Konichi-wa. Ni-bongo-o hanashimasu-ka?*"

"English," said Don.

"Hello," said the robot again. "This is the first time I've been activated since leaving the factory, so I need to ask you a few questions, please. First, from whom do I take instructions?"

"Me and her," Don said.

The robot nodded its basketball head. "By default, I will call you ma'am and you sir. However, if you prefer, I can address you any way you like."

Don grinned. "I am the Great and All-Powerful Oz."

The robot's mouth outline moved in a way that suggested the machine knew Don was kidding. "A pleasure to meet you, Great and All-Powerful Oz."

Sarah looked at the robot with a "see what I have to put up with" expression. Don smiled sheepishly, and she said, "Call him Don. And you can call me Sarah."

"A pleasure to meet you, Don and Sarah. What you are hearing is my default voice. However, if you prefer me to use a female voice or a different accent, I can. Would you like that?"

Don looked at Sarah. "No, this is fine," she said.

"All right," said the robot. "Have you chosen a name for me yet?"

Sarah lifted her shoulders and looked at Don. "Gunter," he said.

"Is that G-U-N-T-H-E-R?" asked the robot.

"No *H*," said Don. And then, unable to help himself, "Get the *H* out."

"My little boy," Sarah said, smiling at Don. She'd said that often enough over the years, but, just now, it seemed to hit a little too close to home. She must have noticed his quickly suppressed wince, because she immediately said, "Sorry."

Still, he thought, she was right. He *was* a kid at heart, at least when it came to robots. And his absolute favorite when he was growing up, as Sarah well knew, was the robot from *Lost in Space*. He got miffed whenever people called that robot Robby, although Robby, the robot from the movie *Forbidden Planet*, did bear a passing resemblance to the one from *Lost in Space*—not surprising, given that they were both designed by the same person, Robert Kinoshita. The *Jupiter 2's* robot was mostly just referred to as "the Robot" (or the "bubble-headed booby" and a hundred other alliterative insults by Dr. Smith). Still, many hardcore *Lost in Space* fans called it B-9, which was the model number it gave for itself in one episode. But Don had always contended that the barrel-chested automaton with vacuum-cleaner hoses for arms was actually named GUNTER, because another episode contained a flashback, showing the robot in its original packing crate, which was labeled "General Utility Non-Theorizing Environmental Robot." Despite pointing this out to people for—God, for over seventy years now—Don hadn't won many converts. But at least now there was a robot in the world who indisputably had that name.

Of course, thought Don, Sarah understood all this. She'd grown up watching *Lost in Space*, too, although what she'd

loved most about it were the photos of real nebulas and galaxies used in space scenes ("Astronomical Photographs Copyrighted 1959 by the California Institute of Technology," the card on the ending credits said). But, he realized sadly, none of this would mean anything to Lenore or anyone else who was as young as he felt.

They continued responding to Gunter's questions for about half an hour, outlining the sorts of duties he was to perform, whether he should answer the phone or door, advising him not to enter the bathrooms when they were occupied unless he heard a call for help, and so on.

But Gunter's principal job was making sure Sarah was safe and well. And so Don said, "Do you know CPR?"

"Yes."

"What about the Heimlich maneuver?" asked Sarah.

"That, too. I'm fully trained in first aid. I can even perform an emergency tracheotomy, if need be, and my palms have built-in defibrillator pads."

"See!" said Don. "He is like Gunter. The real Gunter could shoot lightning out of his claws."

Sarah looked at Don with an affectionate grin. "The *real* Gunter?"

Don laughed. "You know what I mean." He looked at the blue machine. "What do we do with you when we go to bed?" he asked. "Do we turn you off?"

"You may if you wish," said Gunter, and he smiled reassuringly. "But I suggest you leave me on so that I can respond instantly to any emergency. You can also set me tasks to perform while you're sleeping: I can dust and do other chores, and have a hot breakfast ready for you when you get up."

Don looked around the living room, and his eyes landed on the fireplace. "Do you know how to make a fire?"

The robot tilted his head a little to one side, and, if glass lenses could be said to have a faraway look, Gunter's did for a

second. "I do now," he said.

"Great," said Don. "We'll have to get some wood, come winter."

"Do you get bored if you have nothing to do?" asked Sarah.

"No," said the robot, and he smiled that reassuring smile again. "I'm content just to relax."

"An admirable trait," said Sarah, glancing at Don. "I wonder how we ever got along without one."

Chapter 30

Don found himself feeling more and more confused with each passing day. He'd had a handle on life, damn it all. He'd understood its rhythms, its stages, and he'd moved through them all, in the proper sequence, surviving each one.

Youth, he knew, had been for education, for the first phase of professional development, for exploring sexual relationships.

Mature adulthood had meant a committed marriage, raising children, and consolidating whatever material prosperity he had been entitled to.

After that had come middle age, a time for re-evaluation. He'd managed to avoid the affair and sports car then; his midlife crisis, precipitated by a minor heart attack, had finally spurred him to lose weight, and hearing so many women—and some men—tell him how good he looked, how he was hotter at forty-five than he'd been at thirty, had been tonic enough to help him weather those years without needing to do anything more to prove he was still attractive.

And, finally—or so it should have been—there had been the so-called golden years: retirement, becoming a grandparent, taking it easy, an epoch for acceptance and reflection, for companionship and peace, for winding things up as the end approached.

The stages of life; he knew them and understood them: collectively, an arc, a storyline, with a predicable, clichéd beginning, middle, and end.

But now there was suddenly *more*; not just an epilogue tacked on, but a whole new volume, and a totally unplanned one, at that. *Rollback: Book Two of the Donald Halifax Story*. And although Don understood he was its author, he had no idea what was supposed to happen, where it was all supposed to lead. There was no standard plot skeleton to follow, and he didn't have a clue how it was going to end. He couldn't begin to visualize what he should be doing decades down the road; he wasn't even sure what he should be doing in the present day.

But there *was* one thing he knew he had to do soon, although he was dreading it.

"I have something to tell you," Don said to Lenore the next time he saw her.

Lenore was lying naked in bed next to him, in her basement apartment on Euclid Avenue. She propped her head up with a crooked arm and looked at him. "What?"

He hesitated. This was more difficult than he'd thought it would be, and he'd thought it would be *very* difficult. How'd he ever get into a situation in which telling his . . . his . . . his whatever Lenore was . . . that he was married would be the *easy* part?

He let the air out of his lungs through a small opening between his lips, puffing his cheeks out as he did so. "I—um, I'm older than you probably think I am," he said at last.

Her eyes narrowed a bit. "Aren't you the same age as me?"

He shook his head.

"Well, you can't be any more than thirty," she said.

"I'm older than that."

"Thirty-one? Thirty-two? Don, I don't care about six or seven years. I've got an uncle who is *ten* years older than my aunt."

I can do ten years for breakfast, he thought. "Keep going."

"Thirty-three?" Her tone was getting

nervous. "Thirty-four? Thirty—"

"Lenore," he said, closing his eyes for a moment. "I'm eighty-seven."

She made a small raspberry sound. "Jesus, Don, you—"

"*I'm eighty-seven,*" he said, the words practically exploding from him. "I was born in 1960. You must have heard about the rejuvenation process they've got now. I underwent a rollback earlier this year. And this—he indicated his face with a counterclockwise motion of his hand—"is the result."

She scuttled sideways on the bed, like a crab on hot sands, increasing the distance between them. "My . . . God," she said. She was peering at him, studying him, clearly looking for some sign, one way or the other, of whether it was true. "But that procedure, it costs a fortune."

He nodded. "I, um, had a benefactor."

"I don't believe you," Lenore said, but she sounded as though she were lying. "I—I mean, it can't . . ."

"It's true. I could prove it in a hundred different ways. Do you want to see some photo ID, the way I looked before?"

"No!" An expression of . . . of disgust; perhaps, had fleetingly passed over her face. Of course she didn't want to see the old man she'd just had inside her.

"I should have told you sooner, but—"

"You're damn right you should have. Shit, Don!" But then, perhaps the thought occurring because she'd just uttered his name, a glimmer of hope appeared in her eyes, as if she'd realized that this might all be some elaborate put-on. "But, wait, you're Sarah Halifax's grandson! You told me that."

"No, I didn't. You *guessed* that."

She pulled even farther away, and managed to cover her breasts with the sheet, the first hint of modesty he'd ever seen from her. "Who the hell are you?" she said. "Are you even *related* to Sarah Halifax?"

"Yesss," he said, protracting the word into a gentle hiss. "But"—he swallowed hard, trying to keep it all together—"but I'm not her grandson." He found himself

unable to meet her eyes, and so he looked down at the rumpled bedspread between them. "I'm her husband."

"Fuck," said Lenore. "Shit."

"I am so sorry. Really, I am."

"Her husband?" she said again, as if perhaps she'd misheard the first time.

He nodded.

"I think you should leave."

The words tore into his heart, like bullets. "Please. I can—"

"What?" she demanded. "You can *explain*? There's no fucking explanation for this."

"No," he said. "No, I can't explain. And I can't justify it. But, God, Lenore, I never wanted to hurt you. I never wanted to hurt *anyone*." His stomach was churning, and he felt disoriented. "But I want you to . . . to know, to understand."

"Understand what? That everything that has gone down between us has been a lie?"

"No!" he said. "No, no, God, no. This has been more . . . more *real* than anything in my life for—"

"For what?" she sneered. "For years? For *decades*?"

He let out a long, shuddering sigh. He couldn't even protest that she was being unfair. The fact that she was even still *talking* to him was more, he knew, than he had a right to. Still, he tried to defend himself, although, as soon as the words were out, he realized how ill-advised they were. "Look," he said, "you're the one who turned things physical."

"Because I thought you were somebody you *aren't*. You lied to me."

He thought about protesting that he hadn't, not technically, or at least not often. "And, anyway," she continued, "who started things is so beside the point it's not even in the same solar system. You're an *octogenarian*, for God's sake. You're old enough to be my grandfather."

He'd expected those last few words, but they didn't hurt any less for that. "Sarah underwent the same treatment,"

he said, blurting it out. "But it didn't work for her. She's still physically eighty-seven, and I'm . . . *this*."

Lenore said nothing, but her mouth was slightly downturned and her eyebrows were drawn together.

"Cody McGavin paid for it," continued Don. "He wanted Sarah to be around when the next reply comes in from Sigma Draconis. I—I was just along for the ride, but . . ."

"But now you're Sarah's *caregiver*."

"Please," he said. "I didn't ask for any of this."

"No, no, of course not. It all just sort of happened—a multi-billion-dollar medical procedure."

He shook his head. "I should have known you wouldn't understand."

"If you want understanding, go to a support group. There must be one for people like you."

"Oh, yeah. Sure. They're meeting right now, in Vienna. I can't afford to go there. I am—I worked it out—I am four orders of magnitude poorer than the next poorest person who has undergone this process. For every single dollar I've got, they've each got ten thousand dollars. *That's* not being in the same solar system, Lenore."

"Don't snap at me. I haven't done anything wrong here."

He took a deep breath. "You're right. I'm sorry. It's just that I don't know what to do, and . . . and I don't want to lose you. I really do care about you; I haven't been able to stop thinking about you. And I don't know what I'm doing, but I do know this: the only times of late I've been happy—the *only* times—are when I'm with you."

"There must be somebody else who—"

"There's no one. My friends—what few I have who are still alive—they don't understand. And my kids—"

"Oh, crap. I hadn't thought about that. You've got kids!"

In for a penny, in for a pound. "And grandkids. But my son is fifty-five and my

daughter is about to turn fifty. I can't expect them to understand a parent half their age."

"This is crazy," she said.

"We can work it out."

"Are you nuts? You're *married*. You're sixty years older than me. You've got kids. You've got grandkids. And—God, you must be retired, right? You don't even have a job."

"I've got a pension."

"A pension! Jesus."

"This doesn't have to change anything," he said.

"Are you out of your fucking mind?"

"Lenore, please—"

"*Get your clothes*," she snapped.

"Pardon?"

"Get your clothes, and get the hell out!"

Chapter 31

It had been months since Don had seen his grandchildren. He missed them, but he'd been avoiding contact, having no idea how to explain what had happened to him. But, finally, there was no choice. Today, Thursday, September 10, was Emily's fiftieth birthday, and just as attendance for everyone else had been mandatory at Don and Sarah's anniversary party, so his attendance was non-negotiable as his daughter reached the half-century mark.

The party was being held at Emily's house in Scarborough, about an hour away, but an easy journey on the 407. They had Gunter drive them. Don was happy about that. He would have felt silly being driven about by a woman who looked like his grandmother; he still hadn't gotten his license renewed. He'd be required to attend the mandatory driver-safety lectures with a group of other people who were over eighty, and, although the examiner had the power to waive the actual in-car test, Don would still need to endure the gawks from the licensing staff and, even worse, from the old people who *looked* old, many of whom would doubtless resent that he'd

managed to forestall the fate that the rest of them would face in the next few years.

When they pulled into the driveway of the house—a large home that almost completely filled its lot—Don hopped out of the rear and ran around to help Sarah get out of the front passenger's seat. And then, cradling her elbow to guide her up the driveway, they went to the front door, leaving Gunter in the car, placidly looking out at the tiny strip of lawn. Carl and company were already here, but he'd parked his car on the street, leaving the driveway, and the shorter walk, for his parents.

Although the kids' biometrics were programmed into Don and Sarah's house, the reverse had never been the case, and so Don rang the doorbell. Emily appeared at once, looking out at them with apprehension on her face, and she hustled them indoors, glancing furtively back, as if concerned that her neighbors had seen the spectacle of her ancient mother arriving on the arm of some strange young man.

He tried to put that out of his mind, and managed the heartiest tone he could. "Happy birthday, Em!"

Sarah hugged Emily, and, as she did every year, she said, with a smile, "I remember precisely where I was when you were born."

"Hi," said Emily. Don sort of expected "Mom and Dad" to be appended to the greeting; the upward lilt to Emily's "hi" seemed to demand it. But she couldn't say the former without having to also give voice to the latter—and he hadn't heard either of his children refer to him as Dad since the rollback.

This house, like Don and Sarah's own, had stairs leading up from an entryway. Emily took her mother's cane and helped her climb them, and Don followed.

"Grandma!" shouted Cassie, who was wearing a pink floral-print dress and had her wispy blond hair tied into pigtails with pink ribbons. She came rushing

over, and Sarah bent down as much as she could to hug her. When she released Cassie, the little girl then looked at Don without a trace of recognition on her face.

Carl bent down and picked his daughter up, balancing her in a crooked set of arms, the way one might to let a child examine a painting in a museum. "Cassie," said Carl, "this is your grandfather."

Don saw Cassie's little brow furrow. She had an arm around Carl's neck, and she pulled herself closer to him. "Grandpa Marcynuk?" she said, sounding very unsure.

Don felt his heart sink. Gus Marcynuk was Cassie's mother's father; he lived in Winnipeg, and hadn't been in Toronto for years.

"No, honey," said Carl. "This is Grandpa Halifax."

Cassie scrunched her face up even more tightly, and she looked at her daddy as if to gauge his expression—see if he was playing some trick. But his face was serious. "No, it's not," Cassie said, shaking her head so that the pigtails bounced. "Grandpa Halifax is *old*."

Don tried to smile as much as he could. "Honest, cupcake, it's really me."

She tilted her head. Although his voice had changed somewhat, she should still recognize it. "What happened to your wrinkles?"

"They're gone."

Cassie rolled her blue eyes in a way that said he was stating the obvious. He went on. "There's a process," he said, but then he halted. "Process," "procedure," "technique," "treatment"—all the words he'd use in describing this to an adult would be lost on a four-year-old. "I went to see a doctor," Don said, "and he made me young again."

Cassie's eyes were wide. "Can they do that?"

He lifted his shoulders a bit. "Yup."

Cassie looked at Sarah and then back at Don. "What about grandma? Is she going to get young, too?"

Don opened his mouth to reply, but

Sarah beat him to it. "No, dear."

"Why not? Do you like being all wrinkly?"

"Cassie!" exclaimed Carl.

But Sarah didn't take offense. "I've earned every one of them," she said. Sarah obviously saw the puzzled expression on Cassie's face, so she went on. "No, dear, I don't. But the process that worked on your grandfather didn't work for me."

Don watched Cassie nod; perhaps he'd underestimated what little kids could grasp. "That's sad," Cassie said.

Sarah nodded back at her, conceding that.

Cassie turned her attention to her father. "Grandpa looks younger than you do," she said. Carl winced. "When I get old, will they be able to make me young again?"

Don could see that his son was about to respond in the negative; he'd moved his head to the left, ready to shake it. But that wasn't the correct answer. "Yes," said Don. "They will." The process was bound to be cheap and common by the time his granddaughter needed it, and that thought pleased Don.

Carl looked as though he was reaching his limit for holding Cassie. He bent down, setting her on the ground. But then Don crouched low, and turned his back to her. Looking over his shoulder he said, "Want a piggyback ride?"

Cassie scrambled onto his back, and he straightened up. He swooped around the living room, Cassie hugging his neck from behind, and her giggles were music to his ears, and, at least for a few minutes, he was truly happy that he'd had this done to him.

"Hey, Lennie, why so glum?"

Lenore was filling salt and pepper shakers. She looked up to see Gabby regarding her, hands on hips. "Hmm?"

"You've been down in the dumps all night. What's up?"

This was the one evening a week that both Lenore and Gabby worked the

same shift at the Duke of York.

"I broke up with Don a few days ago."

"How come?" asked Gabby.

Lenore pondered how best to answer this. "For starters, he's married."

"The fucker."

"Yeah. But, you know, there are, um, extenuating circumstances."

"Is he separated?"

"No. No, he still lives with her, but . . ."

"But his old lady doesn't understand him, right?"

Lenore felt her mouth twitch. "Something like that."

"Girl, I've heard it a million times before. You're better off without him."

"Yeah, but . . ."

"But what?"

"I miss him."

"Why? Was he good in the sack?"

"As a matter of fact, yes. But it's not just . . ."

"What?"

"He's *gentle*."

"I like it a little rough myself," Gabby said, smiling lasciviously.

"No, no. I mean in life. He's gentle. He's kind, considerate."

"Except to his wife."

Lenore winced. But she recalled when Don had been here before, how he'd defended Professor Halifax when Makoto had attacked her. "No, in his way, he's good to her, too, I think. And she's really sweet."

"You *know* his wife?"

She nodded. "A bit."

"Earth to Lenore! Wake up, girl!"

"I know, I know. But I just can't stop thinking about him."

"Let me get this straight. You dumped Makoto because he was a messy eater—"

"A girl has to have standards."

"—but you want to go back to a *married* guy?"

"No," said Lenore. "I want to go back to him *despite* the fact that he's married."

"I'm not working on any damn master's degree," said Gabby. "Maybe that kind of hair-splitting means something

ANALOG

in your circles, but . . .”

“He’s unlike any guy I’ve ever met.”

“Why? Has he got three nipples?”

“Seriously, Gabs, I miss him so much.”

“Really?”

“Yeah.”

Gabby was quiet for a moment. “Well, then, there’s only one thing to do.”

“What’s that?”

She started transferring the filled shakers onto a serving tray. “Follow your heart.”

At dinner, Sarah ended up sitting next to her grandson Percy, who had turned thirteen over the summer. “So,” she said, “how is grade eight?”

“It’s okay,” he said.

“Just okay?”

“They give us a lot of homework. I’ve got tons to do by Monday.”

Sarah remembered being in grade eight, and getting her first calculator. Such things had only just started to appear on the market, and everybody was debating whether they should be allowed in the classroom. After all, with a machine that could do figuring for them, kids might never learn to really understand math, the critics said. A host of scenarios ranging from the unlikely to the downright silly had been suggested, including the notion that if civilization fell, we’d endure a protracted dark age once the supply of batteries had been exhausted, since the magic boxes that did math would no longer function. Sarah had often wondered if the early appearance of solar-powered calculators had been due to some anonymous Japanese engineer’s desire to put that canard to rest.

And she’d remembered the later debates about allowing datacoms into classrooms. Although that had affected all levels of instruction, it had gone down while she’d been teaching at U of T. Was there any point in asking students to memorize, for instance, that Sigma Draconis II was, according to data from

the first Dracon message, a rocky world about 1.5 times as big as Earth, with an orbital radius of ninety-odd million kilometers and a year equal to 199 Earth days, when there was no conceivable working environment in which they couldn’t access that information in an instant?

“What sort of homework?” Sarah asked, genuinely curious.

“I’ve got some for my bioethics class,” Percy said. Sarah was impressed: bioethics in grade eight; you certainly could move a lot faster if you didn’t waste so much time on mere memorization.

“And what do you have to do?”

“Look up some stuff on the web, and do a report about what I think about it.”

“On any particular topic?”

“We get to choose,” Percy said. “But I haven’t picked mine yet.”

Sarah looked over at Don. She thought about suggesting Percy do something on the ethics of rollbacks, but Don was already too sensitive about that.

“I was thinking of maybe something about abortion,” Percy continued.

She was momentarily shocked. The boy was just thirteen, for God’s sake, but—

But abortion, birth control, and family planning were all things kids needed to know about. Percy’s birthday was in July, meaning he wouldn’t turn fourteen until after he’d finished this grade, but most of his classmates would have their birthdays during the academic year, and fourteen was plenty old enough to get pregnant, or make someone pregnant.

“What do you think about abortion, Grandma?” Percy asked.

Sarah shifted in her seat. She could feel the eyes of Angela, Percy’s mother, on her, as well as those of her own daughter, Emily. “I believe every child that’s born has the right to be wanted,” she said.

Percy considered this. “But what about if a guy and a girl decide they want to have a kid, but then, before it’s

born, the pregnant girl changes her mind. What then?"

There was definitely some of her in her grandson; she'd wrestled a lot with the very issue he'd raised. Indeed, now that she thought about it, that was one of the points the aliens at Sig Drac had been interested in. Question forty-six had asked whether the partner actually carrying the child had the right to terminate a pregnancy that was initially mutually desired. Sarah remembered struggling with her own answer to that question when filling out the survey herself, all those years ago.

She took a sip from the glass of water in front of her. "I go back and forth on that one, dear," she said. "But, today, I think my answer would be that the mother gets the final say."

Percy considered this for a time, then: "You're pretty skytop, Grandma, to talk to me about all this."

"Why, thanks," Sarah said. "I think."

Chapter 32

Don sat on the couch early the next morning, browsing email on his datacom. There were two messages from acquaintances asking for the same thing Randy Trenholm had wanted, an email from his brother forwarding a cartoon he thought Don would like, and—

Beep!

A new message had just arrived. The sender's address was—

My God...

The address was ldarby@utoronto.ca.

He opened the message, and his eyes flew all over it in mad saccades, trying to absorb it as a gestalt. And then, his pulse racing, he re-read it carefully, from top to bottom:

Hey, Don—

Guess you thought you'd never hear from me again, and I guess I don't expect you to answer cuz I know I wasn't that understanding the last time we were together, but, dammitall, I miss

you. Can't believe I'm sending this— Gabby thought I was looped at first—but I was hoping you'd like to get together and talk a bit. Maybe play some Scrabble or ... Anyway, lemme know.

L.

Be kind, because everyone you meet is fighting a hard battle—Plato

Don looked up. Gunter had a perfect sense of balance and could easily carry Sarah, seated in one of the wooden kitchen chairs that had now been conscripted for that purpose, up and down the staircase; they were descending now. "Morning, dear," Sarah said, the usual quaver in her voice.

"Hi," he said.

Gunter put the chair down, and helped Sarah to her feet. "Any interesting email?" she asked.

Don quickly turned off the datacom. "No," he said. "None at all."

Don and Lenore's first day back together had gone well, right up until the evening.

They were just finishing a meal of take-out Chinese food in her basement apartment on Euclid, after an afternoon of walking around downtown, looking in shops. "Anyway," Lenore said, continuing an account of what she'd been up to since Don had last seen her, "the university ripped me off. They say I didn't pay my tuition on time, but I did. I made the electronic transfer just before midnight on the due date. But they charged me a day's worth of interest."

Don never ate fortune cookies, but he still liked cracking them open. His said, "Prospects for change are favorable." "How much?" Don said, referring to the interest.

"Eight dollars," she replied. "I'm going to go by the registrar's office tomorrow and complain."

Don motioned for her to show him her fortune. It said, "An endeavor will

be successful." He nodded, acknowledging that he'd read it. "You could do that," he said, going back to their conversation, "but you'll end up spending half your day dealing with it."

She sounded frustrated with him. "But they shouldn't be able to *do* that."

"It's not worth it over eight bucks," said Don. He got up from his chair and started clearing the table. "You've got to learn to pick your battles. Take it from me. I know. When I was your age, I—"

"Don't say that."

He turned and looked at her. "What?" She crossed her arms in front of her chest. "Don't say shit like, 'When I was your age.' I don't need to hear that."

"I'm just trying to save you from going through—"

"From going through what? Going through life? Spare me from having my own experiences, from learning for myself? I *want* to learn for myself."

"Yes, but—"

"But what? I don't want a *father*, Don. I want a boyfriend. I want a peer, an equal."

He felt his heart sink. "I can't just erase my past."

"No, of course not," she said, noisily wadding up the paper bag the take-out had come in. "They don't make erasers that big."

"Come on, Sarah, I—"

Don froze, realizing his mistake at once. He felt himself turning red. Lenore nodded, as if a vast conspiracy had been confirmed. "You just called me Sarah."

"Oh, God, I'm sorry. I didn't—"

"She's always there, isn't she? Hanging between us. And she always will be. Even when she's—"

Lenore stopped herself, perhaps realizing that she was about to go too far. But Don picked up on the thought. "Yes, she will be, even after . . . even after she's gone. That's a reality we'll have to face." He paused. "Anyway, I can't help the fact that I've been alive longer than—"

"Than ninety-nine percent of all the

people in the world," said Lenore, which stopped him cold for a moment while he thought about whether that was true. He felt his stomach clench as he realized it must be.

"But you can't ask me to *deny* that reality, or what I've learned," he said. "You can't ask me to forget my past."

"I'm not asking that. I'm just asking that you—"

"What? Keep it to myself?"

"No, no. But just don't, you know, always bring it up. It's hard for me. I mean, God, what was the world like when you were born? No home computers, no nanotech, no robots, no television, no—"

"We had television," Don said. *Just not in color.*

"Fine. Fine. But, God, you lived through—through the Iraq War. There was a Soviet Union when you were alive. You saw people walk on the moon. You saw Apartheid end, in South Africa and in the US. You lived through the Month of Terror. You were alive when the first extraterrestrial signal was detected." She shook her head. "Your life is my history book."

He was about to say, "Then you should listen to me when I tell you what I've learned." But he stopped himself before the words got free. "It's not my fault that I'm old," he said.

"I know that!" she snapped. And then, the same words again, but more softly: "I know that. But, well, do you have to rub it in my face?"

Don was leaning against the sink now. "I don't mean to. But you think stuff like a few bucks in interest is a disaster, and—"

"It's not a *disaster*," Lenore said, sounding exasperated. "But it does make my life hard, and—" She must have seen him move his head a bit. "What?" she demanded.

"Nothing."

"No, tell me."

"You don't know *bard*," he said. "Burying a parent, that's hard. Having a

spouse go through cancer is hard. Getting screwed out of a promotion you deserve because of office politics is hard. Suddenly having to spend \$20,000 you don't have on a new roof is hard."

"Actually," she said, rather stiffly, "I *do* know what some of those things are like. My mother died in a car crash when I was eighteen."

Don felt his jaw dropping. He'd avoided asking her about her parents, doubtless because he felt way too *in loco parentis* when he was with her.

"I never knew my dad," she continued, "so it fell to me to look after my brother Cole. He was thirteen then. That's why I work now, you know. I've got enough graduate support to cover my current expenses, but I'm still trying to dig out from the debt I ran up taking care of Cole and me."

"I'm, um . . ."

"You're sorry. Everybody is."

"Was . . . wasn't there any life insurance?"

"My mom couldn't afford that."

"Oh. Um, how did you manage?"

She lifted her shoulders. "Let's just say there's a reason I have a soft spot in my heart for food banks."

He was embarrassed and contrite, and didn't know what to say. Still, it explained why she seemed so much more mature to him than her contemporaries did. When he had been her age, he was still living cozily with his parents, but Lenore had been out in the world for seven years, and had spent part of that time raising a teenager.

"Where's Cole now?" he said.

"Back in Vancouver. He moved in with his girlfriend just before I came out here to do my master's."

"Ah."

"I *do* let most things go," she said. "You know that. But when it comes to someone taking my money—when you've had so little, you . . ." She shrugged slightly.

Don looked at her. "I—I haven't been conscious of being condescending be-

cause of my age," he said slowly, "but now that you've alerted me to it, I'll try to be more . . ." He trailed off; he knew that when he was under emotional stress his vocabulary tended to the highfalutin. But he couldn't think of a better term just then, and so he said it: "Vigilant."

"Thanks," she said, nodding slightly.

"I don't say I'll always get it right. But I really will be trying."

"You certainly will be," she said, with the sort of long-suffering smile he was more used to seeing from Sarah. Don found himself smiling back at her, and he opened his arms, inviting her to stand up and step into them. She did so, and he squeezed her tight.

Chapter 33

Sarah's broken leg was still bothering her, but Gunter was a godsend, gladly bringing her fresh cups of decaf while she sat at the desk in the room that used to be Carl's. She was still working with the stack of papers Don had brought from the university—a hardcopy of the reply that had been sent to Sigma Draconis from Arecibo, and the source material it was based on: the one thousand sets of survey answers that had been chosen at random from those collected on the website. The decryption key must be somewhere buried in there, Sarah felt sure.

It had been decades since Sarah had looked at these documents and she only vaguely remembered them. But Gunter had merely to glance at each page to be able to index it, and so when Sarah said, for instance, "I remember a pair of answers that struck me as contradictory—somebody who said 'yes' to the question about terminating no-longer-productive old people, and 'yes' to the question about *not* terminating people who were an economic burden," the robot had replied, "That's in survey number 785."

Still, she found herself often angry and sometimes even crying in frustration. She couldn't think as clearly as she

used to. Perhaps that wasn't obvious in her day-to-day life of cooking and dealing with grandkids, but it was painfully clear when she tried to puzzle things out, tried to do math in her head, tried to concentrate, to *think*. And she grew fatigued so easily; she found herself often needing to lie down, which just prolonged the work even more.

Of course, many people had already gone back to look at the message sent from Arcicibo to see if it contained the decryption key. And, she realized, if those keen young minds hadn't found it, she likely didn't have a prayer.

Many had suggested that the key might be one particular set of answers, from one of the thousand surveys: a unique sequence of eighty-four responses, one for each question, something like "yes," "no," "much greater than," "I prefer option three," "equal to," "no," "yes," "less than," and so on. There were over 20,000,000,000,000,000,000,000,000,000,000,000,000,000 possible combinations, Sarah knew. Those who didn't have access to the full Arcicibo transmission might be trying sequences at random, but even with the world's fastest computers it would take decades to test them all. Others, of course, did have the full reply that had been sent, and had doubtless already tried using each of the thousand answer strings in turn, but had failed to unlock the message. Sarah continued to pore over the original surveys, looking for something—anything—that might stand out. But, damn it all, nothing did. She hated being old, hated what it was doing to her mind. *Old professors never die*, the joke went. *They just lose their faculties*. It was so funny, as her friends at public school used to say, that she forgot to laugh.

She tried another sequence, but again the message "Decryption failed" flashed on her monitor. She didn't slam her hand down on the desktop in anger—she didn't have the strength for that—but Gunter must have read something in

her body language anyway. "You seem frustrated," he said.

She swiveled her chair and looked at the Mozo, and a thought occurred to her. Gunter was an example of a nonhuman intelligence; maybe he'd have a better idea of what the aliens were looking for. "If it were you, Gunter, what would you have chosen as a decryption key?"

"I am not disposed to secrecy," he said.

"No, I suppose not."

"Have you asked Don?" the Mozo said, his tone even.

She felt her eyebrows going up as she looked at the robot. "Why do you say that?"

Gunter's mouth line twitched, as if he'd started to say something then thought better of it. After a moment, though, he looked away and said, "No special reason."

Sarah thought about letting it go, but . . .

But, damn it all, Don had *his* confidant. "You don't think I know, do you?"

"Know what?" asked Gunter.

"*Pub-lease*," she said. "I can translate messages from the stars. I can certainly pick up signals closer to home."

You could never tell if a robot was meeting your gaze. "Ah," said Gunter.

"Do you know who it is?" she asked.

The Mozo shook his blue head, then: "Do you?"

"No. And I don't want to."

"If I may be so bold, how do you feel about this?"

Sarah looked out the window—which showed some sky and the red bricks of the house next door. "It would not have been my first choice, but . . ."

The Mozo was silent, infinitely patient. At last, Sarah went on. "I know he has . . ." She vacillated between saying "wants" and "needs," and finally settled on the latter. "And I can't become a—*a gymnast*. I can't turn back the clock." She realized she'd said the part about the clock as if citing an archetypal impossibility like "I can't make the sun stand still." But for Don, the hands—

good God, when had she last seen a clock with hands?—had indeed been turned way, way back. She shook her head. “I can’t keep up with him, not anymore.” She was quiet for a time, then looked at the robot. “How do *you* feel about this?”

“Emotions are not my forte.”

“I suppose.”

“Still, I prefer things to be . . . simple.”

Sarah nodded. “Another admirable trait you have.”

“As we have been speaking, I have been accessing the web for information on such things. I freely confess to not understanding it all, but . . . are you not angry?”

“Oh, yes. But not, so much, at Don.”

“I do not understand.”

“I’m angry at—at the *circumstances*.”

“You mean that the rollback did not work for you?”

Sarah looked away again. After a moment, she spoke, softly but clearly. “I wasn’t angry that it didn’t work for me,” she said. “I was angry that it *did* work for Don.” She turned back to face the Mozo. “Awful, isn’t it, that I should be upset that the person I love most in all the world was going to get another seventy years or more of life?” She shook her head, amazed at what she’d found herself capable of. “But, you know, it was because I knew what was bound to happen. I knew he would leave me.”

Gunter tilted his spherical head. “But he hasn’t.”

“No. And, well, I don’t think he’s going to.”

The robot considered this, then: “I concur.”

Sarah lifted her shoulders slightly. “And that’s why I have to forgive him,” she said, her voice soft and faraway. “Because, you see, I know, in my heart of hearts, if the situation had been reversed, I would have left him.”

“How do you feel?” asked Petra Jones, the Rejuvenex doctor, who had come by the house for Don’s latest checkup.

Sarah never sat in on these anymore; it was too much for her to bear.

Don knew he suffered from a misplaced stubborn pride. When his mother had been dying, slowly, painfully, all those years ago, he’d toughed it out. When Sarah was fighting her battle with cancer, he’d kept his chin up, hiding his pain and fear as best he could from her and his children. He was his father’s son, he knew; to ask for help was to show weakness. But he needed help now.

“I—I don’t know,” he said softly.

He was sitting on one end of the couch; Petra, clad in an expensive-looking burnt-orange pantsuit, was at the other. “Is something wrong?” she asked, leaning forward, the beads in her dreadlocks making soft clicking sounds.

Don tilted his head. He could just make out Sarah and Gunter talking, upstairs in the study. “I, um, I haven’t really been feeling like myself,” he said.

“In what way?” Petra said, the words lilting a bit thanks to her slight Georgia accent.

He took a deep breath. “I’ve been doing . . . uncharacteristic things—things I never thought I would do.”

“Like what?”

He looked away. “I, um . . .”

Petra nodded. “Your libido is high?”

Don looked at her, said nothing.

She nodded again. “That’s common. A man’s testosterone levels drop as he ages, but a rollback restores them. That can affect behavior.”

Tell me about it, thought Don. “But I don’t remember it being like this the first time around. Of course, back then . . .” He trailed off.

“What?”

“It was much bigger when I really was twenty-five.”

Petra blinked. “Taller?”

“Fatter. I probably weighed forty pounds more than I do now.”

“Ah, well, yes, that could be a factor, too, in the severity of the hormonal imbalance. But we can make some adjustments. Have you noticed anything else?”

"Well, I'm not just feeling"—there was probably a better, more polite word, but he couldn't think of it just then—"horny. I'm feeling *romantic*."

"Again, hormones," said Petra. "It's common as the body adjusts to a roll-back. Any other problems?"

"No," he said. It had been hard enough alluding to what had happened with Lenore; to give voice to *this* would—

"No depression?" Petra said. "No suicidal thoughts?"

He couldn't meet her eyes. "Well, I..."

"Serotonin levels," Petra said. "They can go out of whack, too, what with all the changes to your biochemistry that happen during a rollback."

"It's not just chemical," Don said. "Bad things have actually happened. I—I've been trying to get a job, for instance, but no one wants me."

Petra lifted a hand slightly. "Just because your depression might be situational doesn't mean it shouldn't be treated. Have you ever been prescribed an antidepressant before?"

Don shook his head.

She got up and opened her leather bag. "All right. Let's take some blood samples; we'll see exactly where your levels of various hormones are right now. I'm sure we can fix everything up."

Chapter 34

Don was at home, lying in bed next to Sarah, when he was awoken from a dream. He and Sarah were standing on opposite sides of a vast canyon, and the gap between them kept widening, geologic forces working in real time, and—

—and the phone was ringing. He fumbled for the handset, and Sarah found the switch for the lamp on her nightstand.

"Hello?" said Don.

"Don, is... is that you?"

He frowned. Nobody quite recognized his voice these days. "Yes."

"Oh, Don, it's Pam." His sister-in-law;

Bill's wife. She sounded hoarse, stressed.

"Pam, are you okay?" Next to him, Sarah struggled to sit up, concerned.

"It's Bill. He's—oh, God, Don, Bill is dead."

Don felt his heart jump. "Christ..."

"What is it?" asked Sarah. "What's wrong?"

He turned to her, and repeated the words, his own voice full of shock now: "Bill is dead."

Sarah brought a hand to her mouth. Don spoke into the phone. "What happened?"

"I don't know. His heart, I guess. He—he..." Pam trailed off.

"Are you at home? Are you okay?"

"Yes, I'm at home. I just got back from the hospital. He was pronounced DOA."

"What about Alex?" Bill's fifty-five-year-old son.

"He's on his way."

"God, Pam, I'm so sorry."

"I don't know what I'm going to do without him," said Pam.

"Let me get dressed and get over there," he said. Bill and Pam normally wintered in Florida, but hadn't yet headed south: "Alex and I, we can take care of all the details."

"My poor Bill," Pam said.

"I'll be there soon," he said.

"Thanks, Don. Bye."

"Bye." He tried to put the handset on his nightstand, but it tumbled to the floor.

Sarah reached over and touched his arm. God, he couldn't remember the last time he'd seen his brother. And then it hit him—

Not since *before*. He normally only saw Bill a couple of times a year, but they did usually go to a Jays game each summer, although Don had begged off this year. This damned laying low, this foolish embarrassment about seeing people he knew, had cost him his last chance to see his brother.

He left the bedroom, walked to the bathroom, and started getting ready to go. Sarah slowly followed him in. He

was about to say she didn't have to come, that he could get Gunter to drive him. But he wanted her with him; he needed her.

"I'm going to miss him," Sarah said, standing next to him by the sink.

He glanced briefly at the mirror above the basin, showing his own youthful reflection, and her aged one. "Me, too," he said, very softly.

"Sarah," said Pam, as they stood at the door to Bill's condominium apartment, "thank you for coming." Don's sister-in-law was a thin woman in her late seventies, short, with high cheekbones. She looked at Don and scowled. She probably recognized the distinctive Halifax features, including the large nose and high forehead, but not the specific face. "I'm sorry . . . ?"

"Pam, it's me. It's Don."

"Oh, right. The rollback. I—I didn't imagine . . ." She stopped. "You look good."

"Thanks. Look, how are you holding up?"

Pam was clearly frazzled, but she said, "I'm okay."

"Where's Alex?"

"In the den. We're trying to find Bill's lawyer's name."

Sarah said, "I'll go help Alex." And she made her way further into the apartment.

Don looked at Pam. "Poor Bill," he said, having nothing better to offer.

"There's so much to do," said Pam, sounding overwhelmed. "A notice on the *Star's* website. Organizing the . . . the funeral."

"It'll all get taken care of," said Don. "Don't worry." He gestured toward the living room, and led Pam further into her own home. "Do you need a drink?"

"I've already got one going." She lowered herself into an amorphous fluorescent-green chair with a tubular metal frame; his brother's taste in furniture had always been more avant-garde than his own. Don found another, matching

chair.

Pam's drink—amber colored, with ice—was on a table by her chair. She took a sip. "God, look at you."

Don felt uncomfortable, and he shifted his gaze to look out the fifth-floor window, taller, more-expensive condo towers filling most of the view. "I didn't ask for it," he said.

"I know. I know. But my Bill—if he'd had a rollback, why . . ."

He'd still be alive, Don thought. *Yes, I know.*

"You were . . . you were . . ." Pam was shaking her head back and forth. She stopped speaking with her thought uncompleted.

"What?" asked Don.

She looked away. The living-room walls were lined with bookcases; Pam and Bill even had bookshelves built-in above the door lintels. "Nothing."

"No, tell me," he said.

She turned back to him, and the anger and betrayal were apparent on her face. "You're older than Bill," she said.

"By fifteen months, yes."

"But now you're going to be around for decades!"

He nodded. "Yes?"

"You were the older brother," she said, as if resenting that it had to be spelled out. "You were supposed to go first."

All Saints' Kingsway Anglican Church had been the church of Don's childhood, remembered now more for the Boy Scout meetings he'd attended there than for anything the minister had said. Don hadn't been in the building for—well, the phrase that came to his mind, no doubt because of his current surroundings, was "for God knows how long," although he didn't in fact believe in a God who kept track of such minutiae.

The coffin was closed, which was just as well. People had always said that Don and Bill looked a lot alike, but Don had no desire to have the comparison—and the contrast—highlighted. Indeed, since

Bill had never had a weight problem, Don looked more like Bill had at twenty-five than he himself had at that age. He was the only one in the room who had known Bill back then, and—

No. No, wait! Over there, talking to Pam, could that be—?

It was Mike Braeden. God, Don hadn't seen him since high school. But there was no mistaking that broad, round face, with the close-together eyes and the one continuous eyebrow; even wrinkled and sagging, it was still obviously him.

Mike had been in Bill's year, but Don had known him, too. One of only four boys on a block mostly populated by girls, Mike—Mikey, as he'd been known back then, or Mick, as he'd styled himself briefly during his early teens—had been a mainstay of street-hockey games, and had belonged to the same Scout troop that had met here.

"That's Mike Braeden," Don said to Sarah, pointing. "An old friend."

She smiled indulgently. "Go over and say hello."

He scuttled sideways between two rows of pews. When he got to Mike, Don found he was doing what one does at funerals, sharing a little remembrance of the dearly departed with the next of kin. "Old Bill, he loved his maple syrup," Mike was saying, and Pam nodded vigorously, as if they'd reached agreement on a nanotech-test-ban treaty. "And none of that fake stuff for him, if you please," Mike continued. "It had to be the real thing, and—"

And he stopped, frozen, as motionless as Bill himself doubtless was in his silk-lined box. "My . . . God," Mike managed after a few moments. "My God. Sorry, son, you took my breath away. You're the spitting image of Bill." He narrowed his beady eyes and drew his one eyebrow, now thundercloud gray, into a knot. "Who . . . who are you?"

"Mikey," Don said, "it's me. Don Halifax."

"No, it—" But then he stopped again.

"My God, it—you *do* look like Donny, but . . ."

"I've had a rollback," Don said.

"How could you—"

"Someone else paid for it."

"God," said Mike. "That's amazing. You—you look fabulous."

"Thanks. And thanks for coming. It would have meant a lot to Bill to have you here."

Mike was still staring at him, and Don was feeling very uncomfortable about it. "Little Donny Halifax," Mike said. "Incredible."

"Mikey, please. I just wanted to say hi."

The other man nodded. "Sorry. It's just that I've never met anyone who's had a rollback."

"Until recently," said Don, "neither had I. But I don't want to talk about that. You were saying something about Bill's fondness for maple syrup . . . ?"

Mike considered for a moment, clearly warring with himself over whether to ask more questions about what had happened to Don, or to accept the invitation to change the subject. He nodded once, his decision made. "Remember when the old Scout troop used to go up north of Highway Seven each winter and tap some trees? Bill was in heaven!" Mike's face showed that he realized he'd probably chosen not quite the right metaphor under the current circumstances, but that simply gave him an incentive to quickly push on, and soon the topic of Don's rollback was left far behind.

Pam was listening intently, but Don found his eyes scanning the gathering crowd for other familiar faces. Bill had always been more popular than Don—more outgoing, and better at sports. He wondered how many people would come to his own funeral, and—

And, as he looked around the room, his heart sank. None of these people, that was for sure. Not his wife, not his kids, not any of his childhood friends. They'd all be dead long, long before he

would. Oh, his grandchildren might yet outlive him; but they weren't here right now, nor, he saw, were their parents. Presumably Carl and Angela were off somewhere else in the church, perhaps busily straightening collars and smoothing dresses on youngsters who had rarely, if ever, had to wear such things before.

In a few minutes, he would present the eulogy, and he'd reach back into his brother's past for anecdotes and revelatory incidents, things that would show what a great guy Bill had been. But at his own eventual funeral, there would be no one who could speak to his childhood or his first adulthood, no one to say anything about the initial eighty or ninety years of his life. Every single thing he'd done to date would be forgotten.

He excused himself from Pam and Mike, who had moved on from Bill's love of maple syrup to extolling his general prudence. "Whenever we were playing street hockey and a car was coming, it was always Bill who first shouted, 'Car!'" Mike said. "I'll always remember him doing that. 'Car! Car!' Why, he . . ."

Don walked down the aisle, to the front of the church. The hardwood floor was dappled with color, thanks to the stained-glass windows. Sarah was now sitting in the second row, at the far right, looking weary and alone, her cane hanging from the rack that held the hymn books on the back of the pew in front of her.

Don came over and crouched next to her in the aisle. "How are you doing?" he asked.

Sarah smiled. "All right. Tired." She narrowed her eyes, concerned. "How about you?"

"Holding together," he said.

"It's nice so many people came."

He scanned the crowd again, part of him wishing it were fewer. He hated speaking in front of groups. An old joke flitted through his brain. The number-one fear of most people is public speak-

ing; the number-two fear is death—meaning, at a funeral, you should feel sorrier for the person giving the eulogy than for the guy in the coffin.

The minister—a short black man of about forty-five, with hair starting to both gray and recede—entered, and soon enough the service was underway. Don tried to relax as he waited to be called upon. Sarah, next to him, held his hand.

The minister had a surprisingly deep voice given his short stature, and he led the assembled group through a few prayers. Don bowed his head during these, but kept his eyes open and stared at the narrow strips of hardwood flooring between his pew and the one in front.

" . . . and so," the minister said, all too soon, "we'll now hear a few words from Bill's younger brother, Don."

Oh, Christ, thought Don. But the mistake had been a natural one, and, as he walked to the front of the church, climbing three stairs to get onto the raised platform, he decided not to correct it.

He gripped the sides of the pulpit and looked out at the people who had come to bid farewell to his brother: family, including Bill's own son Alex and the grown children of Susan, Don and Bill's sister who had died back in 2033; a few old friends; some of Bill's coworkers from the United Way; and many people who were strangers to Don but doubtless meant something to Bill.

"My brother," he said, trotting out the first of the platitudes he'd jotted down on his datacom, which he'd now fished from his suit pocket, "was a good man. A good father, a good husband, and—"

And he stopped cold, not because of his current failings in the category he'd just enumerated, but because of who had just entered at the back of the room, and was now taking a seat in the last row of pews. It had been thirty years since he'd seen his ex-sister-in-law Doreen, but there she was, dressed in black, having come to quietly say good-

bye to the man she'd divorced all those years ago. In death, it seemed, all was forgiven.

He looked down at his notes, found his place, and stumbled on. "Bill Halifax worked hard at his job, and even harder at being a father and a citizen. It's not often—"

He faltered again, because he saw what the next words he'd written were, and realized he'd either have to skip them, or else force the minister's error into the light. *Screw it*, he thought. *I never got to say this when Bill was alive. I'll be damned if I don't say it now.* "It's not often," he said, "that an older brother looks up to a younger brother, but I did, all the time."

There were murmurs, and he could see the perplexed faces. He found himself veering from his prepared comments.

"That's right," he said, gripping the pulpit even harder, needing its support. "I'm Bill's older brother. I was lucky enough to have a rollback." More murmurs, shared glances. "It was . . . it wasn't something I sought out, or even something I wanted, but . . ."

He stopped that train of thought. "Anyway, I knew Bill his whole life, longer than anyone else"—he paused, then decided to finish his sentence with, "in this room," although "in the world" would have been equally true; everyone else who'd known Bill since birth was long gone, and Mike Braeden hadn't moved onto Windermere until Bill was five.

"Bill didn't make many mistakes," Don said. "Oh, there were some, including"—and here he tipped his head at Doreen, who seemed to nod in acknowledgement, understanding that he meant things Bill had done in his marriage, not the fact of the marriage itself—"some doozies that he doubtless regretted right up until the end. But, by and large, he got it *right*. Of course, it didn't hurt that he was sharp as a whip." He realized he'd mangled the metaphor

as soon as he'd said it, but pressed on. "Indeed, some were surprised that he chose to work in the charitable sector, instead of in business, where he could have made a lot more money." He refrained from glancing now at Pam, refrained from conveying the point that Bill never could have afforded what Don himself had been given. "He could have gone into law, could have been a corporate big shot. But he wanted to make a *difference*; he wanted to do good. And he did. My brother *did*."

Don looked out at the crowd again, a sea of black clothes. One or two people were softly crying. His eyes lingered on his children, and his grandchildren—whose children's children he would likely live to see.

"No actuary would say that Bill was shortchanged in quantity, but it's the quality of his life that really stands out." He paused, wondering how personal he should get, but, hell, this was *all* personal, and he wanted Sarah, and his children, and maybe even God to hear it. "It looks like I might get damn near"—he faltered, realizing he'd just sworn during a service, then went on—"double the number of years my brother did."

He looked at the coffin, its polished wood gleaming.

"But," Don continued, "if out of all of that, I can do half as much good, and deserve to be loved half as much as Bill was, then maybe I'll have earned this . . . this . . ." He fell silent, seeking the right word, and, at last, continued: ". . . this *gift* that I've been given." ■

To be concluded.

THE REFERENCE LIBRARY Tom Easton

Strange Birds, Gene Wolfe, DreamHaven Books (912 Lake St., Minneapolis, MN 55408; www.dreamhavenbooks.com), \$10.00, 40 pp. (ISBN: none).

Kings of the High Frontier, Victor Koman, Final Frontier Books (www.bereshith.com), \$24.95, 576 pp. (ISBN: 0-9665662-0-3).

Variable Star, Robert A. Heinlein and Spider Robinson, Tor, \$24.95, 318 pp. (ISBN: 0-765-31312-X).

Wolf Who Rules, Wen Spencer, Baen, \$25.00, 356 pp. (ISBN: 1-4165-2055-4).

Quantico, Greg Bear, Madison Park Press, \$14.99 (SFBC), 357 pp. (ISBN: 1-58288-217-7).

In the Company of Ogres, A. Lee Martinez, Tor, \$13.95, 352 pp. (ISBN: 0-765-31547-5).

The Machine's Child, Kage Baker, Tor, \$24.95, 351 pp. (ISBN: 0-765-31551-3).

Out of the Silence, Erle Cox, Capricorn, \$18.00, 248 pp. (ISBN: 0-9774757-3-5).

Flashing the Dark, Bruce Boston, Samsdot (order from www.projectpulp.com), \$9.95, 102 pp. (ISBN: 1-933556-23-4).

Daughters of Earth: Feminist Science Fiction in the Twentieth Century, Justine Larbalestier, ed., Wesleyan University Press, \$24.95 (paper), 397 + xxii pp. (ISBN: 0-8195-6676-4).

My wife and I recently attended Balticon 40, largely in order to say hello to guest of honor Gene Wolfe (an old friend whom we don't see often enough). While there, we picked up a copy of **Strange Birds**, a limited-edition (1000 copies) chapbook containing two stories Gene wrote in response to the artwork of Lisa Snellings-Clark, who has similarly collaborated with a number of other writers.

"On a Vacant Face a Bruise" tells the tale of Tom, who is drawn to the circus by animal noises, can't get in for lack of money but climbs a tree to watch and is accosted by a strange bird that talks, has little arms under its wings, and wears a fancy shirtfront. Soon, enticed by dolls and animals and birds, Tom is an apprentice-lion tamer traveling from world to world, ever more part of the operation, until the circle closes on a note that suggests pain is the point of life. Classic Wolfe, cryptic and evocative. Much less

cryptic is "Sob in the Silence," which tells us of a horror writer who, hosting an old friend and his family, plots awful deeds and gets exactly what he deserves.

Well worth the price, if DreamHaven has any copies left.

I also picked up a copy of Victor Koman's **Kings of the High Frontier**, released as a limited edition way back in 1998 by Final Frontier Books (part of Bereshith Publishing, most of whose titles seem to be horror). They still have copies, which would seem to reflect more on their approach to marketing via the con circuit than on Koman's skills. After all, Koman is a three-time winner (once for this book) of the Prometheus Award for libertarian SF.

Okay, the Prometheus is not exactly a mainstream award. But the SF community has strong libertarian sympathies, and one would think that any tale of independent spaceship builders who view NASA

as an obstacle on the path to space would find more readers. This is especially true if one considers Greg Benford's Afterword comment that "We'll probably have a Shuttle blow-up before this decade is out." He was a few years off, but it did happen within ten years, and since then NASA has not accomplished much. On the other hand, Bert Rutan has done his best to look like a backyard spaceship builder from the SF of the 1950s.

If you remember the dream, if you think we should have people a lot further out by now, if you love Ben Bova's work, then this one's for you.

In 1955, Robert A. Heinlein outlined a novel, shoved his notes in a drawer, and forgot about it. If he had written it, it might have been one more of the famous Heinlein Juveniles. But he didn't, and his notes were lost to the world until they turned up among his papers well after his death and Spider Robinson—who tells how it all came about in the Afterword—got the job of turning the notes into the novel *Variable Star*.

The plotting bears Heinlein's mark. The writing and the sense of humor is distinctly Spider's, enough so that if you expect to read a new Heinlein novel, you will probably be disappointed. But Art Dula, trustee for the Heinlein estate, told Spider "to take his outline and write the best damned Spider Robinson novel you're capable of." And Spider did that. The novel is easily good enough to occupy a place of honor on any shelf of Spider Robinson books.

Here's the tale: Ganymedeans Joel Johnston has been finishing high school on Earth and dating Jinny. College—where he hopes to study music—looms ahead. But Jinny puts the pressure on until he says yes! He wants to marry her, and then it's off to meet Jinny's family, who turn out to be the richest of rich and *of course* any poor chump who marries into the family will give up all his plans and start studying business. Said poor kid feels pressured and betrayed and immediately

cuts and runs, though not before making a good impression on Jinny's seven-year-old cousin. Since he wants to get just as far away as he can, he signs onto a colony ship. He will never see Jinny again! Good riddance! And What have I done? And Waaahhh!

Yeah, the kid's a mess. But with a little help, he starts to grow up and learn who he is and where he's going, which is a good part of the Heinlein Juvenile recipe. There are complications, of course, but they are all adequately if lightly foreshadowed (e.g., as soon as Spider mentions the Fermi Paradox, the Astute Reader knows that aliens will come into the tale at some point).

Buy it. You'll be glad you did, both because it's a good story and because it is unique in the history of the genre.

When we last saw Tinker (in *Tinker*, reviewed here in April 2004), she had been turned into an elf by a besmitten Windwolf, survived capture by the evil oni, and used her genius to tinker up a hyperdimensional monkeywrench to foil the oni's plans to invade Pittsburgh, which thanks to Tinker's dad and his hyperdimensional gate, has been alternating between Earth and Elfhome for a while now. Wen Spencer had come up with an intriguing blend of SF and fantasy, which—combined with her appealing characters—worked very nicely.

The sequel is *Wolf Who Rules*. Tinker had saved the day, but Pittsburgh was now stranded on Elfhome, there were still oni lurking in the background, and a mysterious hyperdimensional discontinuity in the Turtle Creek district just might mean the threat of an oni invasion was not over. Tinker is investigating the discontinuity when a dragon attacks her. She survives, but now she is plagued by dreams of Oz that seem to be telling her what to do next. Unfortunately, as is the way of dreams, the instructions are not clear and will take most of the novel to figure out. Meanwhile, Tinker is discovering that the mating habits of elves are not

the same as those of humans. She has a glorious husband, but one of her bodyguards is pretty yummy and yes, elves are supposed to be able to play with their bodyguards. Since her body is now elf but her mind is still human, she has some psychological maneuvering to do while she discovers missing family members and the truth about the tengu (half crow, half human), figures out how to save a few astronauts, defeats a dragon, and restores peace to Pittsburgh. And let's not forget to mention the complications of elvish politics.

Spencer's fans will be delighted. Others should pick up a copy of *Tinker* first; they'll then have a two-volume treat in store.

Greg Bear's *Quantico* is firmly rooted in today's headlines. Have you noticed failures of the FBI to prevent crimes? That's why Congress is intent on dismantling the Bureau. Have you wondered why the government feels it necessary to add Homeland Security on top of NSA, CIA, FBI, etc.? The alphabet soup and turf wars are even worse here. Have you heard that terrorism has increased since 9-11? Oh, boy! Or that you can now buy—on eBay, yet!—the equipment to do a spot of genetic engineering, maybe a nice little plague? That's here too. Along with survivalist, polygamist, religious nuts.

The tale begins as a mysterious fellow delivers samples of deadly powder. It sounds like anthrax. Then there's a truckload of inkjet printers toppled beside the road. In due time, we will learn that the printers are part of a nefarious scheme, but first we must drop by *Quantico*, the FBI training academy, to meet what may be the last class, including William Griffin, whose agent dad will soon be badly injured when a bust goes bad and a barn blows up (triggered by the aurora, of all things). The barn looks like a staging center for an anthrax attack, complete with printers and a fireworks launcher, but there's nothing

but yeast on the premises.

It isn't long before Griffin is heading to his dad's hospital room. His classmate Fouad al-Husam has been drafted by the mysterious BuDark and sent to Iraq to investigate anthrax deaths. The truck driver (remember the printers?) has made it back to his base, a defunct California winery (don't forget the yeast) owned by an idiot-savant with enormous lab skills. A plot is becoming apparent, at least to the reader, though the characters still have many clues to stumble upon and piece together.

Which they do, of course. They even get around the rather tricky red herring, and *just* in time. As thrillers go, *Quantico* is fairly standard in structure. Since the author is Greg Bear, the pacing is excellent and the technical details are well and inventively worked out. The business with the printers might actually work, as should the aurora trigger and the fireworks. The genetic engineering, on the other hand, seems a bit of a stretch, which is just as well.

The book appeared first in the UK in 2005. This US edition comes from the book clubs, but don't let that stop you. You'll enjoy it.

Since I enjoyed A. Lee Martinez's *Gil's All Fright Diner* (reviewed October 2005), I was happy to find *In the Company of Ogres* in my mail. Martinez is busily having fun sending up the classic tropes, and if the style isn't heavy on bad puns, it still reads a lot like Robert Asprin.

The protagonist is Never Dead Ned, so named because every time he gets killed, he comes back. Indeed, this seems to be his greatest skill, for though he's a pretty good accountant for Brute's Legion, he really isn't much of a soldier. Perhaps this is why he gets tapped to be the new commander for Ogre Company, a group of misfit troopers heavy on ogres and goblins but with a salamander, an Amazon, a siren, some elves, a few humans (who, it seems, are surprisingly hard to kill), and a history of short-lived commanders. He

gets off to an inauspicious start when a roc squashes him, but the Red Woman soon shows up to poke him back to life.

In the archet trope for this story, Ned would soon display a talent for leadership, whip Ogre Company into shape, and win a major victory or two (remember Asprin's *Phule's Company*?). But no. Ned's a nice guy, but a chump. The siren and the Amazon are soon dueling for his attention, but he's still a chump. An evil wizard wants to pluck out his eye and steal his secret power, but he's still a chump. A demon lord is hunting for him, but he's still a chump. The fate of the universe depends on him, but he's still a chump.

Get it? The poor fellow has to grow up, take some responsibility, get control over his inner demon, and get a life instead of another death. Of course, he does, and the reader enjoys a light, entertaining romp.

Kage Baker has earned praise for her tales of the Company, a.k.a. Dr. Zeus, a future-based outfit that "recruits" through-out time, turns its new troops into immortal cyborgs, and sends them out to fill in the blank spots of history, collect treasures before they are lost, and defend the Company's interests, at least until 2355, when its knowledge of the future stops. The troops are of many human species, even Neandertals and the like, even species that have not yet turned up in the fossil record, and some just don't mingle well with later types. Thus the Company has had to set up places where it can stash the troops it no longer needs. These aren't retirement homes; they're more like file rooms, with the old fellows literally in storage. There is also the "Bureau of Punitive Medicine," where mad, mad Marco tries his best to find a way to kill those immortals the Company wants to get rid of. Alas, no matter what he does to them, even shredding them down to the skull, their immortal bodies regrow. So he must keep trying.

In *The Life of the World to Come* (re-

viewed here in April 2005), we met Alec Checkerfield. He was a "recombinant," a tetraploid constructed from the genetic material of extinct human species. He was also the third of a trio of clones. The first, Nicholas, met and loved the Botanist Mendoza before he was burned at the stake in the 1600s. The second, Edward, was a secret agent of the British Empire who also met and loved Mendoza before he died. Alec met her too, discovering her in exile on an island 150,000 years in the past. Once more they loved, and she gave him information he needed to move forward in his quest to bring down Dr. Zeus. Then he lost her, and in the search for her, he came across and downloaded the recorded minds of his predecessors.

So he's a fairly strange fellow as *The Machine's Child* opens. Alec, Edward, and Nicholas are time-sharing a single body, and it is not always clear who is in charge. Alec's AI, Captain Morgan, runs his time-ship, disguised as a giant schooner, and plots the steps toward bringing an end to the tyranny of Dr. Zeus, making Alec immortal, and finding Mendoza once more. Of course, she turns up in a drawer at the Bureau of Punitive Medicine. Once the Captain has helped her regrow a body and restored some of her memory, she happily if a bit childishly accepts Alec as her love and ignores the way he shifts speech and manner as Nicholas and Edward come to the fore. She also displays much more of her nature as a "Chrome generator," an emitter of strange energies that do strange things with time. And the plot moves on toward 2355 and crisis and perhaps the end of Dr. Zeus.

But Dr. Zeus has other foes as well. For instance, there is Budu, a giant of an Enforcer, slope-browed in the old, old style, put on ice until his one-time protégé Joseph found him and began laboring to restore him to life and potency. There is also Suleyman, who seems to play a more patient game.

In the end, 2355 is closer than ever. Alec, his other selves, and Mendoza are in

a very strange state. The Captain is in possession of what he needs to make Alec immortal and perhaps do other things as well. And at least one more volume will arrive in due time.

Of historical interest is Erle Cox's **Out of the Silence**, first published in Australia in 1919. The tale is rooted twenty-seven million years in the past, when global cataclysms destroyed human society, except for three time capsules bearing individuals whose mission it would be, if they were ever awakened, to restore the glory that was. Cox's prose feels overly simple and unsubtle today, but any reader familiar with Edgar Rice Burroughs will not find it strange. The tale is fairly straightforward, beginning when winegrower Alan Dundas, digging a water hole for his stock, unearths a huge metal dome. Before long he finds the way inside, discovering both obstacles and marvels, and awakens Earani. In due time, the question must be faced: Will Earani save the world, or must the world be saved from her? Her ancient society was founded in the principles of eugenics popular in Cox's time, when overt racism was much more prevalent than it is today. Cox has been criticized for his racist content, but as "Book Wrangler" John Costello notes in his postscript, Cox deserves considerable credit for foreseeing—and condemning—the rise of the eugenic state represented a little later in the twentieth century by Nazi Germany.

Bruce Boston is one of the premier poets of science fiction and fantasy, but he doesn't write only poetry. **Flashing the Dark** is a collection of forty short items. Some are long enough to call stories. Some are situations or paragraphs, prose poems or reflections or even jokes (such as "Shaggy Flea Story"). In all cases, the language is that of the poet, carefully chosen, sometimes cryptic, and the imagery is well off the beaten track.

I enjoyed it.

Today it is not at all uncommon to find

women's names on science fiction and fantasy stories, but for many years the perception was that SF&F was a male field. The writers were mostly male, or at least had male names (such as James Tip-tree, Jr.) or androgynous names (e.g., Andre Norton) or used only initials (e.g., C. L. Moore). And of course only males ever read the stuff!

Sho-ah, as they say out in the country. The truth is that women were among the very first writers in the genre, they've been with us ever since, and they've been reading it, too. If you want proof, get a copy of **Daughters of Earth: Feminist Science Fiction in the Twentieth Century**. Editor Justine Larbalestier has assembled eleven samples of SF&F by women, beginning with Clare Winger Harris's "The Fate of the Poseidonia," which appeared in the June 1927 issue of *Amazing*. Today's reader is struck by how much better it is than many other tales of similar vintage as well as by Gernsback's condescending tone toward it and its author. Is that enough to label it "feminist," as an example of the difficulties posed women by the society of the time? If not, the accompanying essay by Jane Donawerth is quick to point out that it features a strong woman and is concerned with, among other things, "illicit reproduction" in the form of miscegenation and television.

Television? Yeah, I thought that a stretch too, but that's what happens when you turn academics loose, as Larbalestier has done with all the stories here, by Leslie F. Stone, Alice Eleanor Jones, Kate Wilhelm, Pamela Zoline, James Tiptree, Jr., Lisa Tuttle, Pat Murphy, Octavia Butler, Gwyneth Jones, and Karen Joy Fowler, besides Harris. Many of these are writers we have no problem recognizing as feminists today. Beside them, a Harris must seem quite tame. But it is worth remembering that there was in fact a time when a woman who asserted herself by such things as writing a story and putting the manuscript in the mail was committing an act of revolution. ■

Dear *Analog*,
I am enjoying "A New Order of Things" very much. It's the kind of story I've liked in *Astounding/Analog* since I began reading it in 1950.

The August 1953 issue of *Astounding* contained Poul Anderson's "Sam Hall," which told of the close oversight that a government can impose. I couldn't help thinking of the story when I read about the work that the NSA has been doing since 9/11. Cleve Cartmill's story in March 1944 foretold the atomic bomb. I hope that "Sam Hall" isn't as good a prediction.

Kenneth B. Bley
Los Angeles CA

So do I, but it's an eerie and sobering experience to reread it now. . . .

Dr. Schmidt,

In all of the fifty or so years I have read this magazine and its predecessor, I have not once offered my comments or criticisms of the content. There have been occasions when I felt that stories or editorials fell somewhat short of perfection, but I could never see value in criticizing a person's craftsmanship whether I approved of it or not.

Once in a while I do, however, weigh in on disputations that I believe are in need of some light and air. I am referring specifically to Mr. Flynn's critique of Dr. Cramer's article wherein Flynn insists that essentially there was no separation between the science and theology insofar as methodology is concerned. In the first place, science as a separate disci-

pline was unknown. There were theologians and there were so-called philosophers seeking answers to the mysteries of the natural world, some of the time in concert and other times in conflict. Christian theology relied on a tautological system that allowed observable phenomena to be joined with, and in support of, Church dogma while, at the same time, excluding inconsistent, logical conclusions. Then as now, religion was highly politicized, and providing simplistic answers to a largely ignorant population is an ancient method of winning support.

Flynn's assertion that heliocentricity was rejected by the Greeks is not supported by the historical record. Sanskrit texts from the eighth century BC in India describe the sun as "the center of the spheres." An astronomical text called *Shatapatha Brahmana* states that "The sun strings these worlds—the earth, the planets, the atmosphere to himself on a thread." Also: "The sun never sets nor rises. When people think the sun is setting, it is not so; they are mistaken." If that's not heliocentric enough, the famous Greek philosopher, Aristotle, in his work, *On the heavens*, wrote: "At the center is fire, and the earth is one of the stars creating night and day by its circular motion about the center."

My point is that Christian theologians choose the theories that best suited their purposes, much the same way many critics do today. In the modern world, we see half-baked theories presented as science in support of political

goals. Religious leaders are no more qualified to pass judgment on issues of science than they were in the Middle Ages and to speak of ethics as a function of religion strikes me as the purest example of an oxymoron. I believe that the only worthwhile ethos is the search for knowledge.

I recently worked on a project about the life of Giordano Bruno, who was brutally tortured and burned by the Vatican inquisition at the end of the sixteenth century. My research necessarily turned up a lot of details about Galileo, Kepler, and others of that period who fell into disfavor with the Christian hierarchy. I look forward to Mr. Flynn's interpretation of that era with interest.

One final note: I personally know Mr. Flynn and mean him no disrespect. I do, however, object to his "Michaelus of Easton" signature. While he may be in Easton, or at Easton, he definitely is not of Easton. As my Uncle Clayton used to say: "A mouse can build a nest in the oven, that don't make it a biscuit."

Thank you for many years of entertainment and elucidation.

R. K. Glover of Easton,
now in Tennessee

Michael Flynn replies. . .

All that because I pointed out that geocentrism was rooted in Aristotle rather than theology? Forsooth! A long comment containing many points of dispute necessarily requires a long reply. Too long. So I can only respond to selected points. Edit as you like. For the details, I refer the Brasstackians to Grant's *Foundations of Modern Science in the Middle Ages*, Lindberg's *The Beginnings of Western Science*, and the collection edited by Lindberg, *Science in the Middle Ages*, as well as Aristotle's *On the heavens* and Ptolemy's *Syntaxis*, a.k.a. *Almagest*.

1) My letter was not a critique of Dr. Cramer's article—which was as always excellent—only of the easy folk-wisdom passed that the Church insisted the

Earth was in the center of the World *for theological reasons* when it was *for reasons of Aristotelian physics*, and was in conformance with the then-ascertainable empirical evidence. That it was congenial to their theology was lagniappe. Oresme pointed out what Augustine had written ages before, that passages once thought narrative might well be poetical, allegorical, or phrased "in the common sense." Heck, we *still* say "sunrise." In many ways, Galileo would have had an easier time of it had he been born three centuries earlier.

2) Natural philosophers, even those like Oresme, Heytesbury, and others who were also theologians, did not use revelation to determine a question in philosophy, although they sometimes did use them for illustration. See Oresme's *On the causes of marvels*, for example.

3) Why are they "so-called" philosophers?

4) The Latin Christians were not so much "tauto-logical" as "auto-logical," and came in for much criticism for this by later humanists and Protestants. In *Quomodo substantiae*, Boethius famously tried to axiomatize Christianity in the manner of Euclid's elements. As Berengar of Tours wrote [*Rescriptum contra Lanfrannum*], "it is incomparably better to act by reason in the apprehension of truth." And, of course, Aquinas' *Summa theologiae* is the masterwork of this genre. We may suppose them successful or not, as modern tastes run; but the attempt to apply logic *even to their own religious beliefs* was remarkable and historically unparalleled. So much so that Luther would later rebel against "that whore Reason."

5) Citing an "inconsistent, logical conclusion" that was "excluded" would be helpful to those of us of an empiricist disposition. The only one I can think of was whether accidents can exist without inhering in a substance; e.g., can there be "white" without a white "thing"? Yet, this *was* hotly debated, de-

spite the obvious theological consequence. In any collection of millions of people, there are bound to be disagreements.

6) As William of Ockham pointed out, you cannot prove the existence of one thing by the existence of another. What the ancient Indians may have believed tells us nothing about the ancient Greeks.

7) The Aristotle quote, from *On the heavens*, Book II, Chapter 13, is bowdlerized. It actually reads: "*But the Italian philosophers known as the Pythagoreans take the contrary view. At the center, they say, is fire, and the earth is one of the stars, creating night and day by its circular motion around the center*" [emphasis added]. The Stagerite continues: "In all this, they are not seeking for theories and causes to account for observed facts, but rather forcing their observations and trying to accommodate them to certain theories and opinions of their own." I.e., Aristotle was citing the religious beliefs of a fringe group in order to refute them. (They thought Fire was a "nobler" element, and so deserved to be in the center. So, oddly, religious conviction was a source of *heliocentrism*, not of geocentrism. A lucky guess is not science.) For interested readers, <http://classics.mit.edu/Aristotle/heavens.2.ii.html> shows the danger of proof-texting an isolated sentence here or there. (One wonders whether the Indian quotes also suffer from the same defect of context.)

8) If "the only worthwhile ethos is the search for knowledge," why not perform medical experiments on Jews? Why not dictate whom people are allowed to marry, and whether they are allowed to have children? Why not eavesdrop on private conversations? Why not, as Hume proposed, burn all books except those concerning "experimental reasoning" or "quantity or number"? It might be that a search for understanding, or even for love or beauty, may be more worthwhile.

9) Regarding Bruno, it was quite a feat to be excommunicated by Catholics, Calvinists, and Lutherans, and to be kicked out of Oxford by the dons and fired by each of his successive patrons. Interested readers may try Bruno's *Ash Wednesday Supper* here: <http://www.math.dartmouth.edu/~matc/Readers/renaissance.astro/6.1.Supper.html> and discover how little his mysticism owed to genuine science. The translator commented wryly that the *Copernicans* ought to have burned him.

10) The Galileo affair is too long a tale for Brass Tacks, but arrogance, professional jealousy, flamewars, friendship betrayed, anti-Florentine prejudice and anti-Spanish paranoia, international politics, the challenge of Protestant literalism, a possible forgery, and the lack of convincing empirical evidence may indicate a more nuanced event than the usual black-and-white morality play. Galileo wrote to Peiresc [22 Feb., 1635]: "But my most holy intention, how clearly it would appear if some power were to bring to light the slanders, frauds, stratagems, and trickeries that were used eighteen years ago in Rome in order to deceive the authorities!" And again [16 March]: "[Y]ou have certainly understood which was the true and real motive that caused, under the lying mask of religion, this war against me . . ." If Galileo figured there was more to it, I'll go along with him.

11) *I do, however, object to his "Michaelus of Easton" signature. Tongue, meet cheek. Cheek, tongue. Medievals were often so-designated: William of Ockham, Eleanor of Aquitaine, Gerard of Cremona, Hildegard of Bingen, William of Conches, et al. Birth, rearing, and residence ought to qualify me, if not that every ancestor if mine for the past century and a half has lived within fifteen miles of this modest stone house wherein I scribble. Forsooth, indeed!*

Michaelus Eastonensis ■

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UPCOMING EVENTS Anthony Lewis

As always, December is a slow month for SF conventions. . . .

2-5 November 2006

WORLD FANTASY CONVENTION at Renaissance Hotel, Arboretum, Austin, TX. Guests of Honor: Glen Cook & Dave Duncan; TM: Bradley Denton; Editor Guest of Honor: Glenn Lord; Artist Guest of Honor: John Jude Palencar; Robert E. Howard Artist Guest: Gary Gianni. Registration: \$125 until 31 July 2006; supporting \$35. Info: <http://www.fact.org/wfc2006/>; wfcinfo@fact.org; FACT, Inc., Box 27277, Austin, TX 78755.

24-26 November 2006

LOSCON 33 (Los Angeles area SF conference) at Los Angeles Airport Marriott, Los Angeles, CA. Theme: Exploring the Golden Ages of Science Fiction. Guest of Honor: William Tenn; Fan Guest of Honor: Fred Patten. Registration: \$35. Info: www.loscon.org; info@loscon.org; Loscon 33, c/o Los Angeles Science Fantasy Society, 11513 Burbank Blvd., North Hollywood, CA 91601

1-3 December 2006

SMOFCON 24 (Convention runners conference) at Hotel Phillips, Kansas City, MO. Registration: \$60 until 31 October 2006, \$70 at the door; supporting membership \$25. Info: <http://www.midamericon.org/smocon/index.htm>; SMOFCon 24, PO Box 414175, Kansas City, MO 64141-4175.

12-14 January 2007

ARISIA '07 (Boston area speculative fiction conference) at Hyatt Regency, Cambridge, MA. Writer Guest of Honor: Esther Friesner; Artist Guest of Honor: Hilary Scott. Registration: \$35 until 15 December 2006; \$40 at the door. Info: www.arisia.org; info@arisia.org; Bldg. 600, PMB 322, 1 Kendall Sq., Cambridge MA 02139.

30 August-3 September 2007

NIPPON 2007 (65th World Science Fiction Convention) at Pacifico Yokohama, Yokohama, Japan. Guests of Honor: Sakyo Komatsu and David Brin. Artist Guests of Honor: Yoshitaka Amano and Michael Whelan; Fan Guest of Honor: Takumi Shibano. Registration: USD180/JPY20,000 until 30 June 2006, for thereafter. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Nominate and vote for the Hugos. This is only the third time Worldcon will be held in a non-English speaking country and the first time in Asia. Info: www.nippon2007.org; info@nippon2007.org; Nippon 2007/JASFIC, 4-20-5-604, Mure, Mitaka, Tokyo 181-0002. North American agent: Peggy Rae Sapienza, Nippon 2007, PO Box 314, Annapolis Junction, MD 20701, USA. UK agent: Andrew A. Adams, 23 Ivydene Road, Reading RG30 1HT, England, U.K. European agent: Vincent Doherty, Koninginnegracht 75a, 2514A Den Haag, Netherlands. Australian agent: Craig Macbride, Box 274, World Trade Centre, Victoria, 8005 Australia. ■

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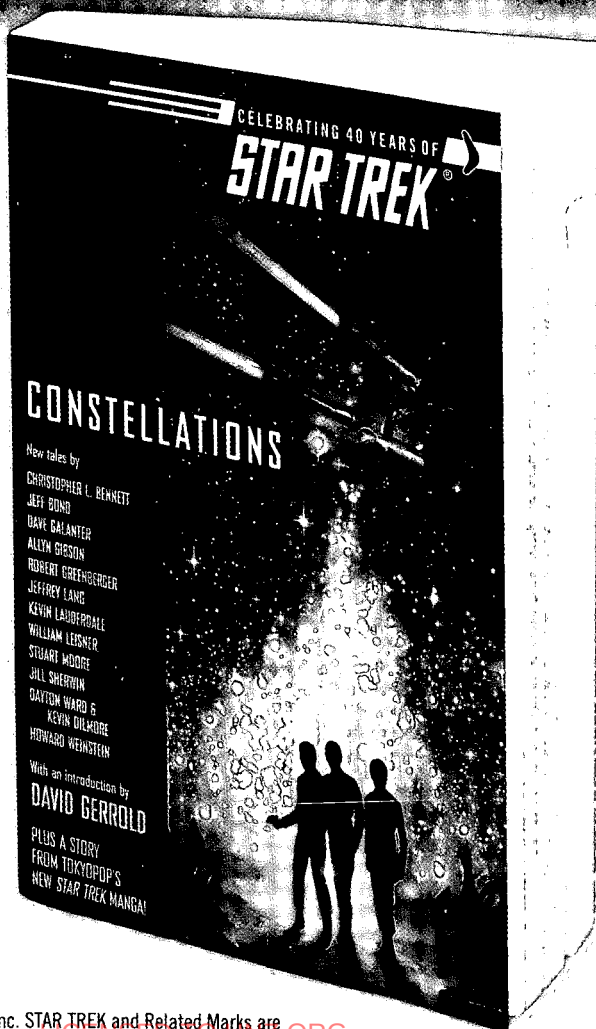
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